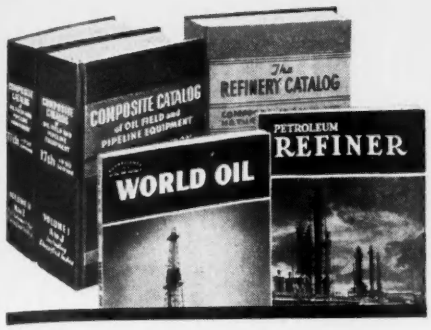

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WORLD OIL and The COMPOSITE CATALOG
for the drilling-producing-pipe line industry

PETROLEUM REFINER and The REFINERY CATALOG
for the refining-natural gasoline industry

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Editor's Page

HOW MUCH IS TOO MUCH?

THE RISING TREND of importation rates at a time when U. S. domestic operators have had to reduce production by substantial amounts draws attention to the question of how much foreign oil imports becomes too much.

There is a wide difference of opinion. Several officials of principal importing companies and the head of the government's Oil & Gas Division recently have stated that current imports are not damaging or seriously affecting the domestic oil industry. Independent U. S. producers have an entirely different view.

Statistically, we find that U. S. January, 1950, crude production was 750,000 barrels, or 13 percent, less per day than in December, 1948; while imports during the same period were increasing by slightly more than 100,000 barrels daily, or 16 percent. Producers in Texas, where most of the curtailment has occurred, have suffered a sharp reduction in income by being limited to 15 producing days monthly.

WORLD OIL heretofore has never taken a position against imports, feeling that past importation rates had not reached excessive volumes. However, common sense dictates that under present conditions imports have reached a point where they are injurious, and that any further increase would seriously damage domestic producers.

DEPLETION ALLOWANCE

THE REDUCTION of the oil and gas industry's depletion allowance from 27½ to 15 percent is proposed by the U. S. Treasury Department as a measure which would increase government revenues by $200 million annually.

Aside from the vital effect of an ample depletion allowance on maintaining an adequate supply of oil in this country and what this means to national welfare and security, the soundness of the proposal may well be questioned on the basis of whether it would actually increase the government's tax revenues.

The Treasury Department has calculated the results of its proposal on the basis of past activity and income from the oil industry, mistakenly assuming that taxes from petroleum and allied dependent business would show no ill effects of the change. To the contrary, national income and government tax receipts might be affected in many ways that cannot now be fully determined. The hope of additional tax revenues might be dissipated in the decline of activities and loss of earnings in oil and allied industries. In the end, government tax receipts probably would not be increased, and might even be seriously decreased.

Any decrease in the depletion allowance would certainly reduce the search for and development of oil and gas producing properties. Less land would be leased, drilling operations would be curtailed sharply, fewer geophysical crews would be employed, and many independent operators likely would be forced out of business. The sale of machinery and equipment to the oil industry would suffer, greatly affecting the use of steel, rubber and other items. Farmers, merchants, royalty owners and many others in sundry lines of businesses now benefit from an active oil industry. The government would lose the taxes generated by the production, income and employment created in all these enterprises.

The scope of oil activity under the depletion allowance which has been in existence since 1926 has permitted the American petroleum industry to find and develop the supply necessary to furnish ever-growing requirements. This also has enabled the American petroleum industry, together with other businesses which are dependent upon it, to contribute ever-increasing taxes to support federal, state and local governments.

Decreased government revenue from all these sources would likely make the proposal self-defeating in terms of raising additional taxes, and therefore unsound for the very purpose that it is being advocated.

Warren L. Baker

Report from the Observatory

International Complications

By RAY L. DUDLEY, Publisher, and WARREN L. BAKER, Editor

STORM SIGNALS which appeared to be gathering on the horizon during February cast a shadow of doubt over the petroleum industry's future prospects. The outlook was particularly darkened by prospects of serious future international market complications and possible adverse changes in U. S. petroleum tax regulations. Either influence could cause sufficient trouble to disrupt the fairly satisfactory prospective course indicated by other factors.

These developments overshadowed current economic trends. Economically, the U. S. industry remained in fairly stable condition. However, there was growing concern over the necessity for further reduction of U. S. crude production and the continued rapid growth of U. S. gasoline stocks to new high volumes.

The possibility of international complications and high level of U. S. gasoline stocks created a fear that crude prices might tumble.

• • •

THE DEPLETION TAX allowance reduction proposed by the U. S. Treasury Department was the main worry of the industry at the moment. The plan to trim the allowance from 27½ to 15 percent would impair operations by endangering the development of sufficient additional oil reserves, forcing many small operators out of business, and raising consumer prices. This important subject is discussed in considerable detail on pages 40 and 41 in this issue.

• • •

INCREASING IMPORTS became a matter of greater concern to domestic U. S. producers, although several major importing companies recently announced reductions in their 1950 crude oil import plans. While the cuts were welcomed and regarded as encouraging trends, they were not seen as providing a solution to the problem. In view of drastic curtailment of U. S. crude production rates, prospective importation rates were seen as still being too high. In addition, it was feared that rising foreign crude production and the British plan to restrict imports of oil produced in dollar currency countries would increase the pressure to ship larger quantities to the U. S.

Announced cuts by five companies represented a decrease of about 42,500 barrels daily from the 793,000 barrels indicated from the first six months of 1950 by findings of the House Small Business Committee in December. This would mean the importation into this country of about 750,000 barrels daily of foreign crude and refined products, considerably higher than the average of 636,000 barrels per day for 1949 and a continuation of the all-time peak of 749,000 barrels per day reached in December, 1949. The latter figure constitutes the latest available statistics on import volumes.

Independents argued that the American industry was just beginning to show the effects of high importation rates, with reduced allowables and income soon to be reflected in the drilling of fewer wells.

• • •

BRITISH PLANS to limit so-called "dollar" oil imports into sterling currency countries was still another matter which became of much concern to the American oil industry during the past month.

Dire consequences might result. The action threatens to squeeze American petroleum companies out of much of the world petroleum markets, which in turn probably would create heavy financial losses for foreign subsidiaries of U. S. oil companies, cause increased imports into U. S. as other markets were shut off, and perhaps bring about a disastrous international price war as American firms attempt to find ways of competing with the sterling currency.

After a series of conferences between American oil company officials and representatives of the British and American governments, many crucial phases remained unanswered. However, it appeared that there was little hope of getting Britain to relax its plans.

• • •

VENEZUELA WAS CONCERNED with both the growing protests against foreign imports into the U. S., and the proposed British restrictions against dollar oil imports. Both the U. S. and Great Britain have been large purchasers of Venezuela petroleum.

In what was an apparent attempt to reduce pressure for import cuts into the U. S. and to ward off the possibility of the U. S. enacting higher oil import tariffs,

Darken Present Oil Outlook

WORLD OIL'S summary of the oil situation at the close of February

Venezuela production in mid-February was trimmed by 150,000 barrels daily from the January 1,450,000 barrel daily rate. The next few weeks may see additional reductions of equal size in Venezuela output.

• • •

THE CRUDE PRICE outlook was placed in considerable doubt by prospects of trouble in the international market.

On one hand, it was feared that price cutting would result from excessive crude supply in Venezuela and parts of the Middle East. Surplus quantities of crude appeared probable in these two areas if British restrictions on sale of American oil in sterling areas were not modified, or if U. S. imports were to be limited below recent rates. Some oil men were of the opinion that surplus production in either Venezuela or the Middle East would lead to a world-wide price war.

On the other hand, any additional growth in U. S. imports of foreign oil was seen by many as endangering the crude market in this country—particularly so since high gasoline stocks already were exerting considerable downward pressure.

Sporadic gasoline price wars in widely scattered sections of the country emphasized the danger that high motor fuel inventories hold for the industry's general price structure. This is especially true on the West Coast, where stocks of crude and all refined products were considerably above year ago levels.

• • •

TOO MUCH GASOLINE was being accumulated in storage. U. S. stocks on February 18 had reached an all-time peak of 131⅔ million barrels, or 9 million barrels over the corresponding period of 1949. This was another matter of growing concern, as excessive gasoline inventories could easily wreck the U. S. industry's price structure.

The outlook was made more discouraging by continued rapid growth in recent weeks, although refiners were reducing runs to stills. During the three weeks ended February 18 crude runs to still averaged 137,000 barrels daily less than in the preceding three weeks, yet motor fuel inventories gained by 7⅓ million barrels during the period or almost identical with the rate of growth in the preceding three weeks.

In contrast with earlier trends, much of the increase recently has occurred outside of California. Motor fuel inventories east of California rose 6⅓ million barrels the last three weeks to stand at 111 million barrels or 2¾ million barrels above year ago levels.

• • •

FURTHER REDUCTION in crude runs to stills is a must, and there is no reason why refiners cannot curtail operations. The end of the heating season now is near enough at hand that the industry is certain it has enough distillate fuel oil available to supply consumption.

Reduced runs would decrease the output of gasoline and prevent continued additions to motor fuel inventories. For their own sake, as well as that of the producers, refiners should do everything possible to lessen the production of gasoline and keep these stocks from going any higher. Because of fixed operating expenses, lower profits for both refiners and producers would result from any reduction in gasoline and crude oil stocks.

• • •

OTHER STOCKS are in good condition. Crude stocks have continued declining, and on February 11 stood at 245½ million, or 11½ million barrels under year ago levels. These inventories have dropped 9 million barrels since the first of the year.

Distillate fuel oil stocks were still being drawn upon at satisfactory rates, and on February 18 amounted to 58 million barrels, only 3⅓ million barrels above year ago levels. Distillate inventories east of California by mid-February had declined to the same level of a year ago.

Residual stocks were in excellent shape, being well below year ago levels both for the nation and in the area east of California. Total U. S. residual inventories on February 18 were 51⅓ million barrels compared with 59⅔ million barrels 12 months previous. East of California stocks had only 23⅔ million barrels of residual in storage, in contrast with 34½ million barrels a year ago.

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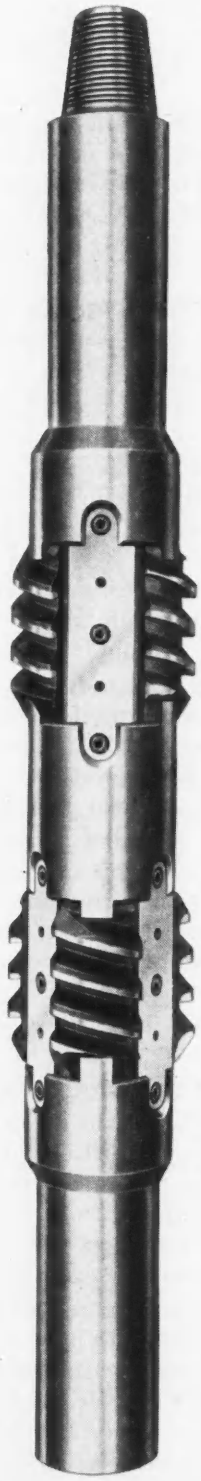

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The Changing Panorama

From Public Power To Socialized Oil

ONE INDUSTRY AT A TIME was the planned and successful way of socializing England. The same plan is being pushed in the U. S., as evidenced in the Truman administration's recent bold advocacy of federal government production and transmission of electric power. (Other significant evidence is found in increased government intrusion into banking and business financing and in constant efforts to gain increased power over the gas industry.)

Heretofore, government control of public power in the U. S. has been sought indirectly, in the name of flood control and soil conservation. Now the President is on record as mentioning specifically "hydroelectric" undertakings, needed to assure an "inexhaustible supply of electric energy." He proposed "Authorities" all over the country and mentioned need of New England states for "cheap government power."

One industry at a time, England nationalized banking, communications, coal mining, electric power, gas utilities, transportation, etc. In the U. S. the socialism threat is not only to electric utilities, but also to banking, communications systems, railroads, truck lines, steel industry, natural gas utilities and producers, and oil companies.

It is only a short step from seeking an "inexhaustible supply of electric energy" through government operation to seeking a similar visionary bountiful supply of petroleum through bureaucracy. And if today presents a need for "cheap government power," tomorrow logically could bring a need for "cheap government gas and oil."

Every threat to any private American industry, such as this threat of socializing the electric power industry, is a threat to every other industry, demanding concerted resistance by all. Individual industries will do well to remember the advice that it is better to hang together than to hang separately. Furthermore, the same advice applies to each individual within the oil industry and every other industry. Destruction of the freedom of a private industry involves at the same time destruction of traditional personal liberties and freedoms of persons working in that industry and of persons buying from or dealing with that industry.

In England, between October, 1947, and December, 1948, according to the Parliamentary Secretary of the Ministry of Labor, "374 directions were issued to men who were in the mining industry compelling them to remain in that industry, and 132 directions were issued to men in agriculture keeping them in agriculture."

In exchange for personal liberties and free choices, the British have a socialized state, which, in spite of imposing burdensome taxes, has provided an economy of austerity and shortages.

In the U. S., let us not be misled by talk about "cheap government power" or any other government product or service alleged to be cheap. We know how costly and cumbersome are virtually all governmental administrations, and how great a burden of taxation we already are carrying in paying for ever-increasing government expansion from political into social and economic affairs—in getting only a part of the way down the road toward a socialized state.

England's experience shows that the cost gets heavier as the road is traveled farther. And the cost is measured not only in monetary income and economic welfare but also in personal liberties.

Government Oil from Alaska and Tidelands

GOVERNMENTAL MOVES toward regulation of the U. S. oil and gas industries have closely resembled those which started the American electric utility industry toward nationalization 15 years ago. The oil and gas industries therefore should vigorously fight trends toward nationalization as evidenced in the electric utility field.

Just as the Muscle Shoals steam plant grew to be the governmentally financed, tax free, politically managed TVA, electric utility men warn, so can the continental shelf, Alaskan reserves, and other governmental steps into the oil industry become government financed and politically managed competing oil organizations, setting prices and offering unfair competition to the remainder of the private tax-paying oil and gas industries.

As government owned business has operated free of taxes, tax burdens have been transferred to citizens and private businesses. This is an important reason for present high and burdensome taxes and for present difficulties in securing equity and risk capital for business.

Men of the electric power industry approve generation of hydroelectric power when it is economic at government flood control and reclamation projects. But they insist that the power should be sold at full value, as measured by costs of other means of producing its equivalent, without benefit of government subsidy or freedom from taxes; using income on this basis to benefit the projects and encourage and finance more reclamation, irrigation, and flood control. This should be done, they declare, instead of securing additional government money, building transmission lines that often are not needed, selling power at less than true cost and half its real value, with benefit of government subsidy, and using income for more duplication of tax-paying private utilities.

Residual and Coal Versus Diesel Oil

ALTHOUGH DIESEL-ELECTRIC locomotives have threatened to displace steam locomotives burning coal and residual fuel oil, diesel oil henceforth may meet strong competition from both coal and residual.

Through Bituminous Coal Research, Inc., nine major coal-carrying railroads and five major coal companies are seeking to develop a coal-fired gas turbine locomotive comparable with the diesel locomotive in efficiency. A stationary locomotive-size gas turbine, fueled by pulverized coal with combustion efficiency above 90 percent, was operated successfully on a 38-hour run. A similar turbine, due to power the first coal-burning gas turbine locomotive, has been built, and another is on order.

Meanwhile, using residual fuel oil for fuel, the country's first gas turbine-electric locomotive has performed successfully in actual road tests, under almost every conceivable operating condition. Using residual or bunker fuel oil, the engine uses a gas turbine to drive electric generators, which in turn furnish power to the wheels. This type locomotive ultimately may replace diesel-electrics, some predict, as it burns lower cost oil, weighs less than half as much per horsepower, and requires far less cooling.

Monthly News Analysis

Reserve Productive Capacity Of Nation Relatively Large

Through exceptionally active wildcatting and field development during the past several years, the industry has steadily expanded proved U. S. reserves, consistently developing new reserves in greater volume than existing reserves were being drawn down through production.

Results have been so successful that the industry is getting back toward a normal peacetime situation on reserves, with developed fields capable of producing materially more oil than current requirements.

The industry has been successfully fulfilling its responsibility for assuring the nation ample oil supply for all peacetime needs and adequate reserve producing ability to meet extra needs of any national emergency.

Fields of the U. S. at present have efficient producing ability more than 1 million barrels a day in excess of actual current production. This much excess productive capacity was conceded to exist in the conservative estimates embodied in the recent report of the National Petroleum Council committee on crude petroleum reserve productive capacity. The report stated that availability of all liquid hydrocarbons apparently reached 6,450,000 barrels daily in December, 1949. In that month, production averaged about 5,478,000 barrels daily, including 5,003,500 crude and 474,500 natural gasoline. That committee also pointed out that "In case of an emergency, rationing should make available 1 million barrels daily of oil for emergency use, which would be as valuable for national security as reserve productive capacity of that amount."

Estimates from other sources make the NPC estimates of present producing ability appear conservative, as one source credits Texas with a potential more than 1 million barrels per day above its current actual production, while Louisiana, Oklahoma, California, and some other states now are producing substantially less, through curtailment, than they easily and efficiently could produce if the extra output were needed.

Large Texas Potential Makes Output Proration Difficult

Texas alone now has efficient crude oil producing ability 1 million barrels per day in excess of current actual production, it was stated at the February 17 statewide proration hearing of the Texas Railroad Commission. The large excess of potential output above actual production, now causing difficulties in proration, has been caused in considerable part by the development during the past year of the prolific Scurry County, West Texas, pools.

Chief Engineer Jack K. Baumel of the Railroad Commission stated at the hearing that 117,000 Texas wells can produce without waste slightly more than 3 million barrels of crude per day. February allowables averaged 2,025,000 barrels per day, and purchasers' nominations for March were 14,329 barrels per day below February.

Since a large part of Texas state allowables is committed to stripper and certain other classes of wells, present strict allowables put severe pinch on remaining wells. Baumel explained that 1,360,000 barrels per day of the Texas allowable goes automatically to small wells guaranteed production by marginal wells law, in bonuses to discovery wells, and to fields exempt from shutdown because of physical condition. This leaves about 665,000 barrels per day market demand to be distributed among wells capable of producing at least 1,650,000 barrels daily. For these wells, allowables therefore are only about 40 percent of producing potential.

Texas Allowable Is Reduced; Basis for Quota Changed

In recognition of reduced requirements revealed by crude purchasers in their nominations for March, the Texas Railroad Commission in its changed-basis proration order of February 24 set Texas allowable crude production for March at 1,944,122 barrels daily, a cut of 92,161 barrels from the current allowable averaging 2,036,283 barrels per day. Aside from lowering the state's total allowable, the March order was significant because it reinstated the 1947 system of determining well allowables, based on acreage and well depth, instead of continuing the more recently employed method based on "maximum efficiency rate" (MER), a system that made producing ability the determining factor.

The new order provided for "shut down" days as earlier orders have done, but called for the same number in all fields, whereas previous orders have made an exception of the East Texas field, allowing it fewer producing days. Under the March order, all fields including East Texas, will be allowed 17 producing days. In February, all fields were allowed 15 producing days except East Texas, which was allowed 13 days. While March will give two extra producing days for Texas fields generally and four additional days for East Texas, as compared with February, there are three more calendar days in March than in February.

Change of basis for allocating Texas allowable production among wells was precipitated by increasing production potential in face of continuing curtailed demand. Several formulas for prorating Texas allowable production among wells were discussed at the statewide hearing of the Texas Railroad Commission at San Antonio February 17, all of a nature that would reduce quotas of high allowable fields, such as Scurry County. In that area, top allowable per well has been 220 barrels per day under proration based on maximum efficiency rate. It was stated at the hearing that by going back to the "yardstick" allocations of 1947, based on well depth and acreage, a Scurry County well would get a top allowable of about 111 barrels daily, or half the existing maximum.

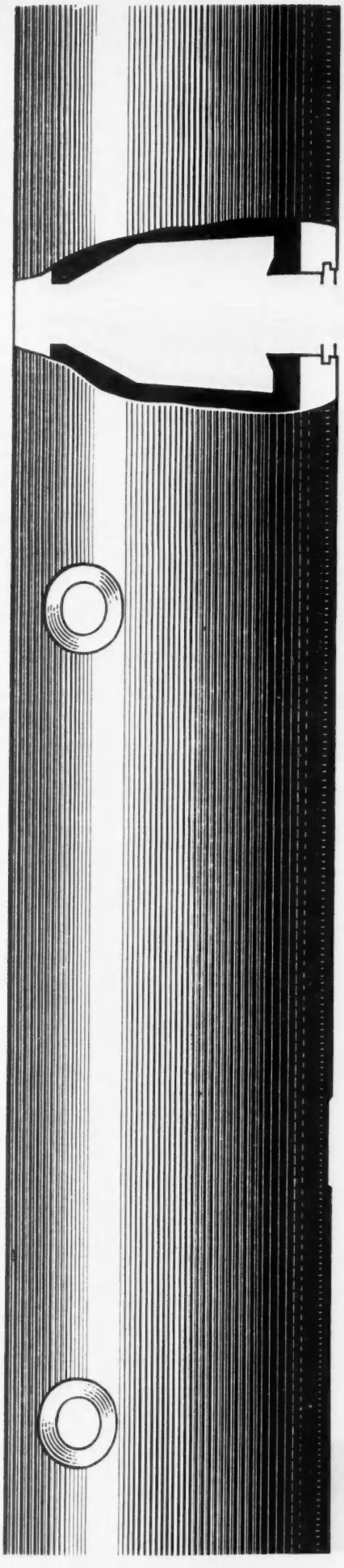
Need for modernizing Texas marginal well law also was brought out at the San Antonio hearing. Guaranteeing an allowable to every well, according to depth, the law provides a maximum of 35 barrels per day for wells 6000 to 8000 feet deep. Though that covered deepest wells when the law was enacted 18 years ago, many wells now are deeper than 8000 feet.

Overcrowded Storage Forces Louisiana Allowables Lower

Full storage, especially of gasoline, was an important factor in causing reduction of allowable crude production in Louisiana to 537,000 barrels daily for March, a cut of about 40,000 barrels from February. Several major purchasers had made reductions in their nominations for March, and one had asked for emergency reduction of February allowables, but this was not ordered.

The reduction for March will be made through a change in the statewide "depth bracket" system, used since July of last year, rating each well according to its producing depth.

At the Louisiana statewide proration hearing for determining March allow-



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ables, a representative of one company charged that Louisiana crude production was above requirements, having similar effect on the country as foreign oil imports.

S. L. Digby, State Conservation Commissioner, said that the amount of imports was sufficient to affect domestic production; that he would like to see an equitable balance worked out within the industry instead of through legislation; and that he deprecated reduction of Louisiana allowables at expense of local producers when the situation was largely the result of imports.

Overproducers in Oklahoma Commit Industry Hara-Kiri

Hara-kiri is not an "old American custom" but some Oklahoma operators are trying to gut themselves and the oil industry as well.

No one wants a cut in the price of crude, but some Oklahoma producers are inviting a reduction.

This reference is to the prevalent practice of producing more oil than the state's allowable. Not all producers are guilty, and a few are not aware that they are running more oil than they should, but the sum total amounts to the same thing.

Oklahoma is definitely out of line insofar as keeping within the Corporation Commission allowables is concerned.

Last year, Oklahoma producers ran more oil every day, execpt in January, than they should. The state overproduced by 7,816,949 barrels for the year.

Here are the figures, plus and minus signs indicating barrels per day underage and overage: January, 1949, —21,126 (only month in 1949 under allowable), February + 9659, March + 36,356, April + 30,473, May + 27,359, June + 21,722, July + 23,145, August + 38,565, September + 42,074, October + 5015, November + 17,388, December + 26,063.

It is not the fault of the Oklahoma Corporation Commission, which has insufficient men to police all fields in the state. It appears that most of the overage is coming from old areas where allocated pools call for a production of 35 barrels of oil per well on each lease. A break in the crude oil price would hit the small producers first, and hardest.

Apparently many producers who are running more oil than the allowable don't read the newspapers. Else they give mere lip service to the cause of doing everything possible to maintain a strong crude oil market by, for example, demanding that crude oil imports be cut down, only to turn right around and produce more oil than they are legally permitted.

Such flouting of allowables is scarcely fair to other states, such as Texas, which has held the line and where producers have long felt the squeeze because of allowables which have cut until it hurts.

Fortunately for Oklahoma and the Mid-Continent in general, and especially because of painful but effective production curtailment in Texas, accumulation of surplus U. S. stocks of crude has been avoided during the past year. However, those operators who observe the allowables do not feel there is any warrant for illegal overproduction. The satisfactory situation on crude stocks could easily deteriorate, and the Mid-Continent might again find itself with bulging tanks, as it did two years ago.

Crude oil prices have remained stable, although there have been some feather-edge adjustments. These could spread, since the crude oil price is maintained in delicate balance.

There are many factors today which could bring about a slash in wellhead prices. Certainly those operators who persist in producing more oil than the legal allowable are in a dangerous position and are contributing materially to conditions which could upset the price structure.

Outlook Dim for California Oil Conservation Legislation

Outlook for passage of an oil conservation measure during or immediately following the Budget Session of the California Legislature in March of this year appear to be dim in view of the fact that as yet the Governor has not seen fit to call the legislative body into special session.

The proposed oil conservation law, actively sponsored and supported by the Oil Producers Agency which has for its membership approximately 50 percent of the state's independent operators, would be modeled after similar measures adopted and used for years by other oil producing states. The proposed bill, drawn up in outline form in which extracts of the principles are set forth, was slated to have been considered by the Legislature at a special session which could be called only by the Governor.

Recent instances in which oil and gas allegedly were wastefully produced in town-lot type development, together with the feeling prevailing that the federal government's anti-trust division does not look with favor on the present voluntary conservation system, have brought about renewed interest in such legislation.

Congressional Study Likely As Imports Reach New Highs

With U. S. oil imports currently estimated at a new high of about 800,000 barrels daily, demands for their curtailment have become increasingly insistent, and Congressional action on the problem is being invited.

Independents late in February protested to Secretary of Interior Oscar Chapman regarding testimony of Hugh Stewart, director of Interior Department's Oil & Gas Division, before the House Commerce Oil (Harris) Subcommittee. Stewart had advised against "any abrupt action in any direction" in regard to oil imports. Russell Brown, counsel for Independent Petroleum Association of America, in a letter to Chapman, declared, on the contrary, that "abrupt" and "precipitous" measures are the "kind of action needed today" to curb rising imports. Brown said Stewart's views might be accepted as those of the Interior Department and implied hope that a different view would be taken by the Department in the report it is understood to be preparing for President Truman.

Stewart had expressed the hope that imports could be reduced to levels where they would "supplement" and not "supplant" domestic production. Government policy regarding oil imports is complicated, he said, by many factors, including the effect on relations with other countries and divided opinions of groups concerned with the problem. O&GD is concerned, he said, with various aspects, including long range effects (5 to 10 years) and national security. At same hearing, E. B. Swanson, assistant director of O&GD, expressed the opinion that oil imports have not yet reached the point where they seriously and adversely affect the domestic industry. He said imports now are about 800,000 barrels per day but he expected decreases in latter part of the first quarter of the year. He said he saw no adverse effects on exploration and development, but conceded that some small refiners are having difficulties.

The House Labor (Lesinski) Committee has undertaken an investigation of the effect of imports generally on the domestic labor situation, at the instance of Rep. Steed (D., Okla.), who was expected to be made chairman of a subcommittee to make the study. Steed said he was particularly concerned over effects of oil imports on employment in oil fields and at refineries in his home district.

Congress Considering Bills Concerned with Natural Gas

Several bills concerned with regulation of the natural gas industry are under consideration in Congress. In the Senate, committee action is being sought on an amended or substitute version of the Kerr-Thomas bill, revised by the authors in an effort to make it acceptable to the President. The original Kerr-Thomas

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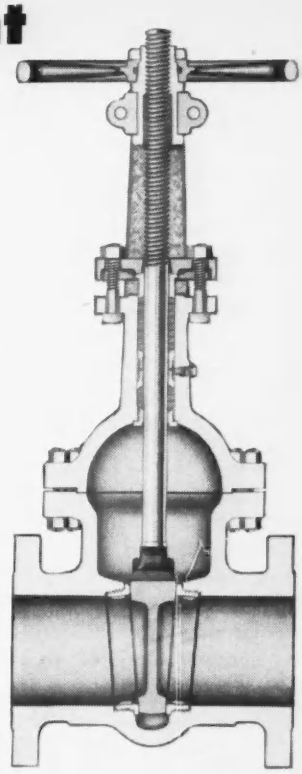

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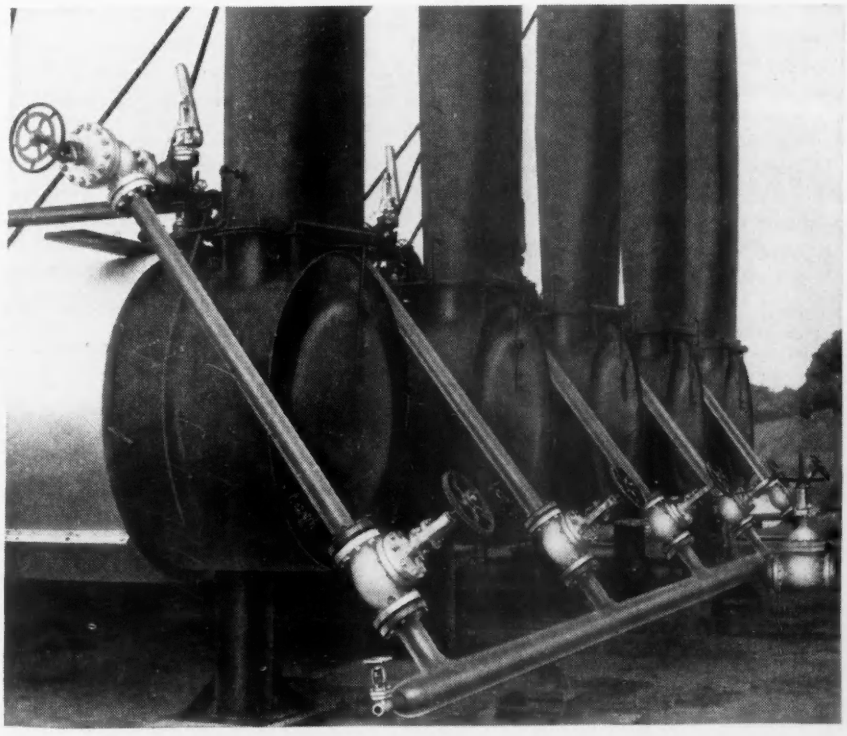

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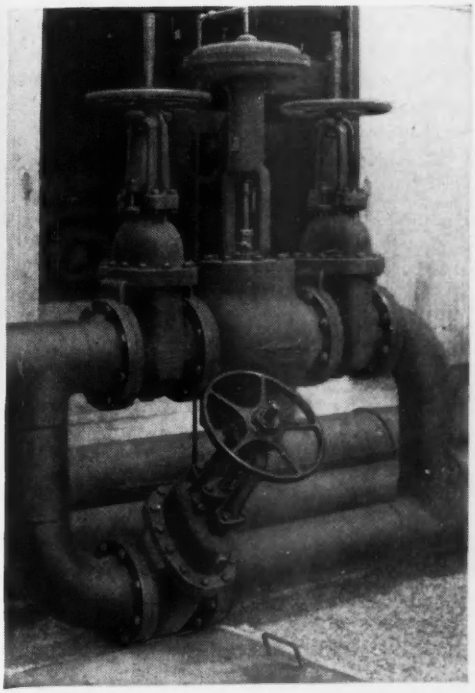

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bill (S. 1498) was approved in Senate committee, and a similar measure, the Harris bill, has been approved by the House; both of these deny Federal Power Commission any authority to regulate independent production and gathering of natural gas. The substitute Kerr-Thomas bill differs from the original in that it directs FPC to keep a continuing check on prices and make appropriate recommendations to the President and Congress if it believes prices are getting out of line. The original bill raised the contention it would cause higher prices for consumers.

Attorneys for the Independent Petroleum Association of America have urged delay by a House committee of action on the Crosser bill (H. R. 5306), pending the outcome of the Harris and Kerr-Thomas bills and a clarification of who would be subject to terms of the Crosser bill. Under the Crosser bill, FPC would regulate issuance of securities by natural gas companies subject to FPC jurisdiction. Independents fear this measure might provide an additional opening wedge for FPC to extend its jurisdiction into production and gathering activities.

Independent Natural Gas Association of America has publicly opposed enactment of the Crosser bill. An attorney for the association declared that the bill would give FPC "broad and unbridled administrative power to determine what is proper and what is compatible with the public interest" in the issuance of securities.

State Corporation Commission May Set Gas Price at Wellhead

A far-reaching decision was recently handed down by the Oklahoma Supreme Court giving the Oklahoma Corporation Commission the right to set the price of natural gas at the wellhead. The 5 to 4 ruling came on a case instituted after gas producers sought to force buyers in the Guymon-Hugoton field in the Oklahoma Panhandle to pay the price set by the Commission, which is 7 cents per thousand cubic feet.

The decision has been received with mixed feelings by those interested in producing and transporting natural gas. Royalty owners are well pleased, as are natural gas producers, who stand to gain millions of dollars over a period of years if the decision stands. However, buyers of natural gas are going to fight the decision to the limit and will take it to the U. S. Supreme court.

All in the industry agree that a fair price for natural gas is justified. But, what is a fair price? This is a question that has plagued natural gas producers for years and they have good reason to hope that the U. S. Supreme Court will uphold the Oklahoma judiciary. The producer of natural gas, until recent years, has had to accept whatever a taker cared to offer for the product, ranging from 1 cent and painfully advancing up to 4 and 5 cents.

But the real question is whether state regulatory bodies have any right whatsoever to fix the price of natural gas. The Oklahoma Corporation Commission contends that rate-fixing is justified as a conservation measure; that it has such a right, so as to fulfill its function of preventing waste. Officials have made it clear that they are not interested in the economic angle—just in conservation. Buyers express the fear, however, that if a state body is permitted to regulate the price of natural gas, then by the same token it has the right of fixing the price of oil, coal, and other minerals—all in the interest of conservation.

Is this a measure leading to government control?

Some segments of the gas industry apparently think it is.

Strangely, oil producers and buyers have not taken the decision with the same gravity that the natural gas industry has; perhaps they believe that "it can't happen to oil." Those who are affected, however, point out that this ruling, if upheld by the U. S. Supreme Court, will eventually affect the buyers of crude oil as well.

One natural gas company vitally affected by the ruling declared that it is fighting the order because it is opposed to any price fixing powers for state regulatory bodies. The company points out that in many instances it is paying more than the 7 cents fixed by the Oklahoma Corporation Commission, and so its fight is not a selfish one, but based on constitutional grounds. If permitted to stand, a company official declared, the ruling will hamstring private enterprise all along the line.

If the U. S. Supreme Court upholds the Oklahoma Supreme Court, other state regulatory bodies will use the power to fix prices of natural gas at the wellhead. For the Kansas part of Hugoton field, for example, the Kansas Corporation Commission already has ordered a minimum price of 8 cents, and the order has been upheld in a state district court, though the case is expected to be appealed to the Kansas Supreme Court and if necessary to the U. S. Supreme Court.

If the ruling stands, the price of natural gas to the consumer may be expected to increase, since higher field costs generally require higher prices.

Crude Prices to Remain Stable, Analyst Predicts

Crude oil prices will probably stay at their present level for the foreseeable future, Albert J. McIntosh, Socony-Vacuum Oil Company analyst and economist, told the Security Analysts Society in Boston last month. McIntosh said: "A year ago I thought the price of crude might drop. Since then several difficult adjustments have been made in the industry. So that's favorable. There was practically no net change in inventory levels during 1949, while in 1948 stocks were piling up almost 300,000 barrels a day. That's also good. Demand appears to be on the increase again after some adjustments and hesitations. Imports may slow up somewhat and crude production in the U. S. may have to increase about 4 percent over 1949 to take care of 1950 requirements. These factors are all favorable to a maintenance of firm crude oil prices."

McIntosh conceded that "on the other hand, the present high price may be resulting in too much exploration for present requirements. We may have added another 1.2 billion barrels of reserves last year. If that is true, we found enough in 1949 at that rate to give us a production of about 275,000 barrels a day for 12 years. I don't think we need that much additional new oil in 1950, so we may find our discoveries running somewhat on the high side."

He predicted that oil companies' sales would increase about 350,000 barrels a day for the country's domestic business in 1950, although exports would drop. "However," he said, "we can reasonably expect a net increase of 5 percent for over-all requirements."

He forecast domestic sales increases as follows: gasoline, 4 percent; kerosine, 6 percent or more; home heating oils, diesels, and other light fuels, 14 percent; but for heavy industrial fuel oils a 2 percent decrease.

"One thing we should bear in mind," McIntosh added, "If 1950 weather is just normal, we will have a gain of at least 1½ percent without any new customers. So we are conservative when we say an increase of 5 to 6 percent in total domestic demand because that includes the 1½ percent adjustment for weather. After allowing for a decline in exports, the over-all increase may be within a half percentage of the above figures."

He said "industry conditions look pretty good," but pointed out that refiners have been in a tight spot, "and producers lost production in 1949 as compared with 1948—some 465,000 barrels a day. Half of this loss was the elimination of the overproduction of 1948, or the production for stock-building in 1948 not needed again in 1949. Warm weather also hurt the producer and probably was the cause of 15 percent of the decline in his crude requirements."

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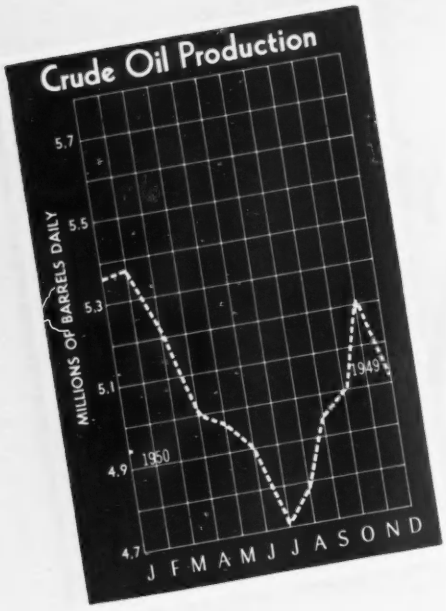
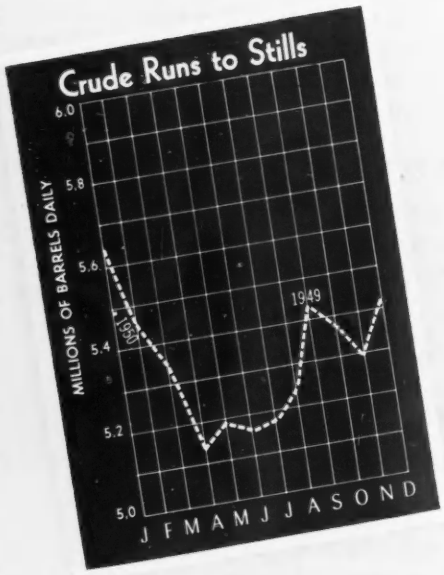
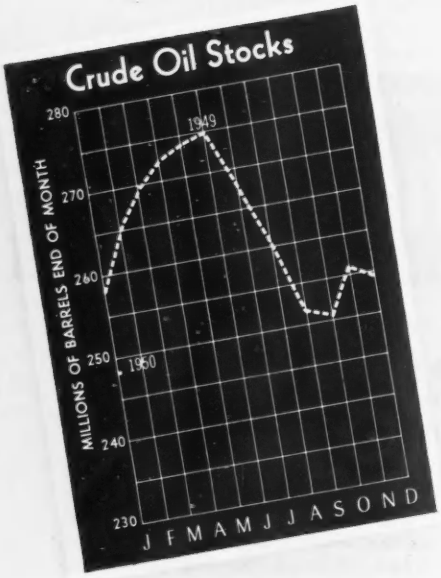






January Gasoline Stocks

By CECIL W. SMITH,

MORE crude was refined in January than in any month since the same period of 1949. While this stepup did lower crude stocks to a more comfortable working level, it did not help the gasoline situation. Motor fuel stocks, because of the refining hike, were swelled to within 2 million barrels of the all-time peak that was on hand at the end of March of last year. The fact that stocks were nearing the all-time high mark is not particularly noteworthy in itself, but the significant factor is that this level was being reached two months earlier than last year.

The amount of gasoline that will be put into tanks up until the end of March is the important consideration. Unless refiners ease up on gasoline output during those several months, stocks would certainly soften the gasoline market, which in turn would exert strong pressure on crude prices.

The improvement in crude stocks during January was not entirely the result of increased refining activity, for reduced crude production also played a part. The month's crude output was lower than it had been in the previous three months and was only slightly higher than that of last September.

Stocks of the fuel oils continued to be drained off during the month, despite the general mildness of the weather, and there appeared to be no threat of an over-supply situation arising. Prudent control of fuel oil production has prevented the temperate weather from causing an excessive pile-up.

Runs to refinery stills during January averaged 5,491,000 barrels a day, a hike of 69,000 barrels a day over December's rate, but 150,000 a day less than the January, 1949, average. However, the month's operations were the highest since January a year ago.

Stocks of finished and unfinished gasoline jumped 12,130,000 barrels during January to total 125,627,000 barrels at the month's end. That amount was 9,006,000 barrels more than was in tanks at the same time last year, but it was also only a little more than two million barrels less than the all-time high of 128,000,000 barrels reached in the latter part of March.

Crude Oil and Refined Products Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month
1948:									
January	5,283	5,348	229,842	2,328	102,167	1,082	39,788	1,278	36,260
February	5,353	5,380	231,419	2,264	110,999	1,127	33,019	1,295	35,602
March	5,406	5,387	234,164	2,252	111,949	1,050	30,570	1,307	34,192
April	5,484	5,540	234,506	2,396	109,289	978	32,564	1,303	35,527
May	5,502	5,668	231,318	2,486	108,552	992	38,551	1,314	41,123
June	5,544	5,632	231,412	2,529	104,518	998	45,835	1,280	44,213
July	5,522	5,631	230,955	2,494	98,839	994	56,045	1,264	49,448
August	5,577	5,621	231,954	2,532	95,445	1,038	65,887	1,248	55,009
September	5,435	5,376	237,302	2,416	90,518	961	73,854	1,154	58,682
October	5,632	5,594	243,972	2,490	92,426	1,069	79,992	1,268	61,456
November	5,675	5,672	250,066	2,551	95,589	1,081	80,658	1,277	64,865
December	5,688	5,720	256,254	2,626	103,697	1,106	71,475	1,299	64,021
1949:									
January	5,365	5,641	258,648	2,538	116,621	1,063	61,584	1,348	62,508
February	5,376	5,480	265,216	2,484	126,054	1,004	53,937	1,282	59,398
March	5,224	5,352	269,341	2,470	127,443	993	48,923	1,258	58,190
April	5,012	5,141	272,520	2,494	125,351	846	51,231	1,147	59,668
May	4,972	5,195	273,912	2,585	121,602	813	57,442	1,138	63,576
June	4,903	5,162	274,691	2,597	114,041	771	64,730	1,041	64,628
July	4,704	5,173	267,586	2,613	111,217	835	71,553	1,040	66,084
August	4,780	5,241	260,585	2,593	104,879	902	76,037	1,078	66,843
September	4,940	5,427	251,689	2,617	101,799	1,002	83,213	1,110	67,117
October	4,997	5,373	250,932	2,643	103,287	1,001	90,643	1,141	68,673
November	5,210	5,293	256,010	2,594	104,707	962	88,212	1,180	65,112
December	5,004	5,422	254,449	2,400	113,497	1,036	77,801	1,211	61,675
1950:									
January	4,943	5,491	248,285	2,617	125,627	1,060	65,352	1,178	55,988
Jan., 1950 Change:									
In Month	−61	+69	−6,164	+217	+12,130	+24	−12,449	−33	−5,687
In Year	−422	−150	−10,363	+79	+9,006	−3	+3,768	−170	−6,520

Trends in U. S.

Near March, 1949 Level

Statistical Editor

1949. Which is to say that motor fuel stocks are almost two months ahead of schedule in comparison with last year.

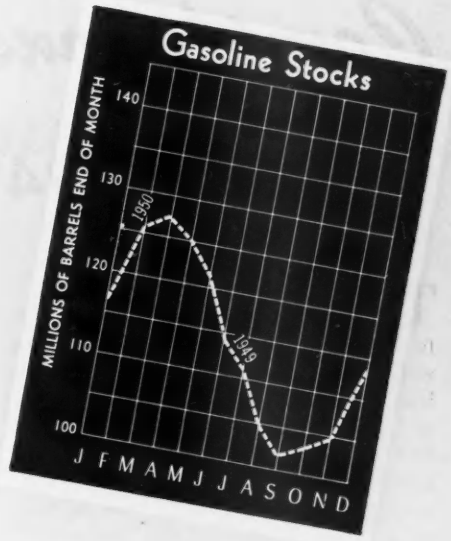
Should gasoline stocks be allowed to accumulate at the recent rates, they will undoubtedly become excessive and burdensome before the heavy demand season starts. If this excess became too great, lower gasoline prices would occur, which in turn would exert downward pressure on crude oil prices, as gasoline is pretty much the profit-margin product in today's refining.

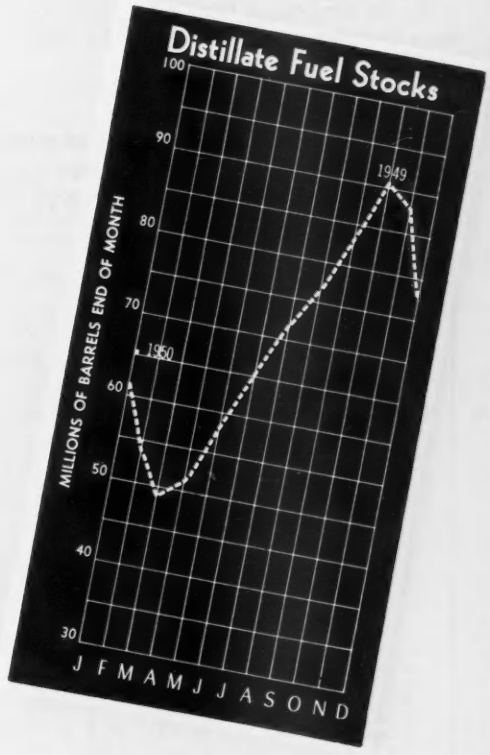
The latest statistical report issued by the American Petroleum Institute indicated that not much had been done to prevent gasoline stocks from building at the January rate. During the first 18 days of February, API reported that inventories had risen about 6,000,000 barrels since the last of January and were totaling 131,600,000 barrels.

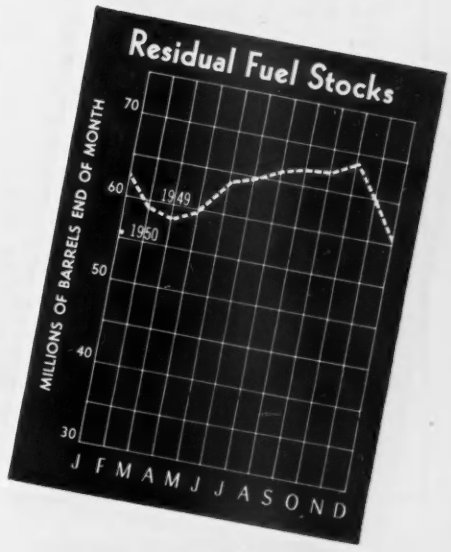
Crude stocks were lowered 6,164,000 barrels during the month and ended totaling 248,285,000 barrels. These stocks had been allowed to get a little too high during November due to a production hike, but during the last two months they have been whittled back to the level regarded as proper for working stocks.

Drafts totaling 12,449,000 barrels during January dropped distillate fuel stocks to 65,352,000 barrels. That amount was only 3,768,000 barrels more than the industry had on hand a year earlier. At the end of December, these stocks had been 6,326,000 barrels ahead of a year ago.

The only principal refined product whose end of January stocks were trailing last year's accumulations was residual fuel oil. After reductions of 5,687,000 barrels during the month, these stocks totaled 55,988,000 barrels.







State Crude Oil Production

(THOUSANDS OF BARRELS)

STATE or DISTRICT	DAILY AVERAGE PRODUCTION				TOTAL PRODUCTION		
	Jan., 1950	Dec., 1949	Jan., 1949	% Diff. Jan, '49-'50	Jan., 1950	Jan., 1949	% Diff. '49-'50
Alabama	1.6	1.5	1.2	+ 31.6	50	38	+ 31.6
Arkansas	82.7	78.7	84.9	— 2.6	2,563	2,631	— 2.6
California	868.1	868.8	940.5	— 7.7	26,912	29,156	— 7.7
Colorado	59.9	62.0	65.7	— 9.0	1,855	2,039	— 9.0
Florida	1.0	0.9	1.3	— 17.9	32	39	— 17.9
Illinois	180.3	178.8	166.6	+ 8.3	5,590	5,163	+ 8.3
Indiana	27.5	28.2	21.5	+ 27.7	852	667	+ 27.7
Kansas	268.9	284.2	283.7	— 5.2	8,335	8,796	— 5.2
Kentucky	26.3	25.3	22.5	+ 17.2	816	696	+ 17.2
Louisiana	562.7	558.5	521.5	+ 7.9	17,443	16,166	+ 7.9
North Louisiana	129.6	129.6	124.9	+ 3.7	4,016	3,871	+ 3.7
South Louisiana	433.1	428.9	396.6	+ 9.2	13,427	12,295	+ 9.2
Michigan	44.0	44.5	47.2	— 6.9	1,362	1,463	— 6.9
Mississippi	101.5	100.8	115.5	— 12.1	3,147	3,580	— 12.1
Missouri	0.1	0.1	0.1	.....	3	4	— 25.0
Montana	23.5	22.9	24.5	— 4.1	730	761	— 4.1
Nebraska	1.4	1.4	0.7	+114.3	45	21	+114.3
New Mexico	129.8	130.3	131.1	— 1.0	4,023	4,065	— 1.0
New York	13.4	13.4	11.8	+ 13.1	415	367	+ 13.1
Ohio	9.0	9.1	8.3	+ 8.1	279	258	+ 8.1
Oklahoma	401.7	409.6	434.8	— 7.6	12,454	13,480	— 7.6
Pennsylvania	28.0	27.6	31.7	— 11.8	867	983	— 11.8
Tennessee	0.1	0.1	0.1	.....	3	1	+200.0
Texas	1,955.3	2,014.8	2,333.9	— 16.2	60,614	72,353	— 16.2
Dist. 1—South Central	26.2	26.1	27.1	— 3.1	813	839	— 3.1
Dist. 2—Middle Gulf	114.8	119.5	164.8	— 30.4	3,559	5,110	— 30.4
Dist. 3—Upper Gulf	375.8	387.1	468.9	— 19.9	11,649	14,535	— 19.9
Dist. 4—Lower Gulf-S.W.	180.9	189.5	228.9	— 21.0	5,606	7,097	— 21.0
Dist. 5—East Central	32.7	34.3	46.5	— 29.7	1,014	1,442	— 29.7
Dist. 6—Northeast	306.9	326.2	410.3	— 25.2	9,515	12,721	— 25.2
Dist. 7-B—North Central	62.3	61.5	62.8	— 0.7	1,932	1,946	— 0.7
Dist. 7-C—West Central	47.0	51.3	48.5	— 3.2	1,457	1,505	— 3.2
Dist. 8—West	573.6	586.2	678.0	— 15.4	17,781	21,017	— 15.4
Dist. 9—North	142.7	140.7	138.9	+ 2.7	4,423	4,305	+ 2.7
Dist. 10—Panhandle	92.4	92.4	89.3	+ 3.5	2,865	2,767	+ 3.5
Utah	3.1	2.9	0.2	+1840.0	97	5	+1840.0
Virginia	0.1	0.1	0.1	.....	3	3	.....
West Virginia	7.6	7.8	6.8	+ 11.8	237	212	+ 11.8
Wyoming	145.3	131.2	133.1	+ 9.2	4,506	4,125	+ 9.2
Total United States	4,942.9	5,003.5	5,389.4	— 8.3	153,230	167,072	— 8.3

Completions

Top 1949 Period

THE year's drilling campaign got off to a good start in January when 3376 wells were completed for a substantial lead over activity in the initial month of last year. While these wells totaled 12.4 percent more than the 3003 completions of a year ago, there was an even greater difference in the amount of footage drilled in the comparable month's tests.

By the time all of January's wells had been completed, 12,940,683 feet had been drilled. Compared with 10,913,006 feet penetrated in January, 1949, that was an increase of more than 18 percent. The increase in the number of wells accounted for part of this increase in footage, but principally it was due to deeper wells. January's new wells were exceptionally deep as their average of 3869 feet was several hundred feet deeper than the 3666 average of a year ago.

Although this year's drilling jumped into an early lead over last year's, the outlook is still one of slightly less activity for 1950. At least, less activity as far as the number of wells is concerned, but a slight gain in total footage is expected. WORLD OIL, in its Review-Forecast Issue, estimated that 1950's wells would trail those drilled in 1949 by 0.5 percent, while footage would top the 1949 all-time peak by 1.5 percent.

Early months' operations are generally not too indicative of things to come during the remainder of the year, and this fast start made in January is expected to give ground and yield the lead to 1949 within the next several months. A good indication that this will happen is the decline in the number of active drilling rigs that has occurred in the past several months. The most active drilling year in history was 1948 and it will be remembered that at the outset such a record was certainly not in evidence. The same was true in 1949, which became second only to 1948 in the number of wells drilled.

Well Completions in the United States During January, 1950

(Figures compiled by WORLD OIL Staff from private reports and other sources as follows: Illinois from Illinois Geological Survey: Indiana from Indiana Division of Geology: Missouri from Missouri Geological Survey: Tennessee from Tennessee Division of Geology: Bradford, Kane-Clarendon and Allegany fields of Pennsylvania and New York from The Producers Monthly)

STATE or DISTRICT	MONTHLY COMPLETIONS—Details for January, 1950									Total Drilled Deeper	Total Completions			Percent Difference From Year Ago	Total Footage January, 1950	Rigs in Operation (Drilling, Rigging Up and Shut Down)		
	NEW WELLS																	
	Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	Total New			Jan., 1950	Dec., 1949	Jan., 1949			Jan. 31, 1950	Dec. 31, 1949	Jan. 31, 1949
Alabama	1			2				3			3	4	1	+200.0	13,996	3	2	6
Arizona																4	3	8
Arkansas	18	1		12				31			31	31	16	+ 93.8	100,926	22	25	30
California	117	1	1	39				158		11	169	150	207	— 18.4	787,245	257	206	295
Colorado				5				5		2	7	8	3	+133.3	19,275	4	14	23
Florida	1							1			1	1	2	— 50.0	11,576	4	4	4
Georgia				1				1			1				5,265		1	
Idaho																2		
Illinois	94			82				176			176	299	149	+ 18.1	398,014	181	234	227
Indiana	36		4	61				101			101	120	77	+ 31.2	191,716	123	138	122
Kansas	125		27	99			9	260			260	242	199	+ 30.7	892,246	299	302	269
Kentucky	22		23	15				60			60	74	77	— 22.1	126,689	84	86	72
Louisiana	127	25	11	69			1	233		1	234	244	168	+ 39.3	1,488,639	236	236	197
North Louisiana	55	8	7	40			1	111		1	112	164	85	+ 31.7	440,048	69	75	61
South Louisiana	72	17	4	29				122			122	80	83	+ 47.0	1,048,591	167	161	136
Michigan	28		2	36				66		1	67	51	74	— 9.5	160,763	133	135	104
Mississippi	17	4		13				34			34	26	21	+ 61.9	252,356	25	34	35
Missouri			2	2				4			4	6	1	+300.0	1,824	7	7	9
Montana	3		2	4				9			9	7	18	— 50.0	22,306	17	35	52
Nebraska	2		1	2				5			5	1			21,945	8	7	
New Mexico	39	2	5	11				57		1	58	37	40	+ 45.0	249,141	90	95	87
New York	43				27			70			70	80	109	— 35.8	96,662	101	105	148
North Dakota												1						1
Ohio	25		15	22				62			62	80	104	— 40.4	139,676	174	152	164
Oklahoma	213	4	20	129	11	1	3	381		9	390	345	324	+ 20.4	1,367,172	534	540	474
Pennsylvania	40		26	8	35	8		117			117	124	252	— 53.6	210,841	230	245	344
South Dakota				1				1			1				5,710		2	2
Tennessee													3	—100.0		11	7	10
Texas	891	17	52	425	6		2	1,393		15	1,408	1,197	1,048	+ 34.4	5,968,414	1,314	1,398	1,366
Dist. 1—South Central	13		1	22				36		2	38	54	49	— 22.4	96,841	34	33	42
Dist. 2—Middle Gulf	26		3	9				38		1	39	59	39		224,759	40	43	50
Dist. 3—Upper Gulf	84	6	7	31				128			128	124	123	+ 4.1	697,224	113	125	143
Dist. 4—Lower Gulf S.W.	70	1	12	60	1			144		2	146	114	112	+ 30.4	665,710	100	111	127
Dist. 5—East Central	4		2	7				13			13	17	26	— 50.0	64,794	17	21	33
Dist. 6—Northeast	48	4	4	16				72		2	74	75	79	— 6.3	326,619	34	42	35
Dist. 7-B—North Central	57		5	90				152			152	143	142	+ 7.0	462,108	159	167	199
Dist. 7-C—West Central	44	4		27				75		2	77	56	23	+234.8	352,512	88	90	74
Dist. 8—West	317	1	1	50				369		6	375	213	176	+113.1	2,001,399	453	479	404
Dist. 9—North	152	1	4	111	5		2	275			275	257	158	+ 74.1	798,397	174	181	125
Dist. 10—Panhandle	76		13	2				91			91	85	121	— 24.8	278,051	102	106	134
Utah				3				3			3	4	1		10,383	5	8	13
Virginia																1	1	
Washington												1				1		
West Virginia	11		32	13				56			56	51	55	+ 1.8	151,928	250	242	336
Wyoming	34			15				49			49	43	54	— 9.3	245,975	60	91	113
Total United States	1,887	54	223	1,069	79	9	15	3,336		40	3,376	3,227	3,003	+ 12.4	12,940,683	4,180	4,355	4,511

Looking Ahead

U. S. CRUDE OIL PRICES over long-term future must and will be higher. This in order to cover increased costs of finding and developing the new reserves which are so essential to our economy and national defense. This opinion was expressed by Floyd B. Odlum, financier and president of Atlas Corporation, in connection with deal whereby Atlas sold its holdings of more than 40 percent of Barnsdall Oil Company to Sunray Oil Corporation and reserved option to buy from Sunray 750,000 shares of Sunray common stock. Odlum stated that cost of finding and developing new reserves seems to be constantly increasing in U. S. until at present, for industry as a whole, considering all elements of cost, it is generally estimated to be well in excess of $1 per barrel.

OIL COMPANY EARNINGS are expected to be less in 1950 than in 1949, because of lower average prices of crude and products, following declines of past year. Helping to hold earnings up around 1949 levels, however, will be the anticipated moderate increases in demand for oils and volumes of business. For oil industry as a whole, earnings in 1949 were about 28 percent lower than in 1948.

AUTOMOBILE MILEAGE PER GALLON of gasoline will be increased 30 percent through fuel research now in progress, predicted T. A. Boyd, Detroit, consultant to General Motors Research Laboratories. "Better fuels will enable motor car manufacturers to make engines with higher compression ratios which get at least 30 percent better fuel mileage than today's motor cars," he explained to American Chemical Society at Dayton February 14. Gasoline contains immense unused reserve of energy, he said, one gallon having enough to drive 3000-pound automobile 200 miles at 30 miles an hour if that energy could be converted into "push" for the car with no loss of efficiency.

DRILLING IN OFFSHORE WATERS up to 350 feet deep soon may become commonplace if plans now being formulated for construction of a new-type, portable drilling platform are consummated. Immediate objective of the designer of the equipment is the drilling of California offshore areas beyond the 100-fathom tideland limit, claim for which formally was made some months ago. According to the inventor, use of the new portable platform, as compared with fixed platforms presently being used in the Gulf area, may cut costs of offshore drilling by as much as 60 percent.

WHILE FEDERAL GOVERNMENT claim to tidelands oil apparently can be neither affirmed nor rejected by legislation in this Congress, the claim as based on existing law draws nearer judicial settlement. The U. S. Supreme Court has set March 13 as date for hearing arguments in cases involving federal claims to Texas and Louisiana tidelands. President Truman asserts federal claim, could not get legislation affirming it, but by veto power probably could block federal quitclaim legislation.

RESERVES OF APPROXIMATELY 1 BILLION BARRELS are estimated to have been developed in the Scurry County, West Texas, reef play in the 14 to 15 months since discovery of North Snyder field. At middle of February about 375 oil wells had been completed and about 160 wells were drilling in the several pools of the area. High gravity oil (41 to 45 degrees), moderate depths (6500 to 7000 feet), comparatively easy drilling, and a preponderance of independent operators, have contributed to the unusually rapid but orderly development of this significant play. A complete, detailed article on this reef development will appear in an early issue of WORLD OIL.

Percentage

Industry Presents Strong Case Against Reduction

OIL industry leaders rushed to defend the depletion allowance in two days of testimony before the House Ways and Means Committee last month and then withdrew to await a decision which none dared predict.

Actually, it was less a defense than a hurried assault upon a phalanx of statistics so shining and arguments so lustrous as to have recently bedazzled the President of the U. S.

Fronted by some of oildom's sharpest minds, buttressed by sound statistics, and heard by Congressmen not without sympathy for the cause, the industry did well. But the Treasury Department may have been planning this sally since 1942, the year Morgenthau was shellacked on these same grounds, and it had planned too well to be easily silenced.

Treasury's strategy seemed to hinge on two major points:

● *The Advantage of Surprise.* On January 13 the President lulled the industry by telling Rep. Albert Thomas he had no intention of tinkering with the allowance. Ten days later he lashed out with his "loophole" speech. This was clearly a storm warning, but lacking knowledge of how much the administration aimed to cut the allowance, the industry could not properly prepare its case.

On February 3 Treasury Secretary Snyder asked Congress to reduce the allowance from 27½ to 15 percent. Plan was to have Treasury present its carefully polished brief on February 6, allowing the ill-prepared industry the following day—and no more—for rebuttal. But the plan went awry when industry got one day's grace because of a Republican Party Caucus, and another February 14 despite disapproval in high places.

IPAA President Sums Up Evils of Proposed Cut

J. Ed Warren of Midland, president of the IPAA, which has been waging a vigorous fight in the Congress and the press against the Treasury's proposal, summarized for World Oil some of the industry's major objections:

". . . Elimination of depletion allowances will result in:

"First, in a reduction of the ability of the small independent oil producer to compete and survive with the larger units of the industry.

"Second, that the increased taxes received by the government will eventually be absorbed by the consuming public to increase petroleum product prices.

"Third, the removal of depletion allowances and intangible drilling costs will retard the exploratory effort to discover oil and will eventually make the nation dependent on foreign sources of petroleum for a considerable amount of its vital needs."

● *Divide and Conquer.* The administration attempted to deprive the industry of the support of the Congress and the public by dangling the half-promise that the hateful wartime excise taxes might be slashed if the revenue could be made up by reducing the depletion allowance.

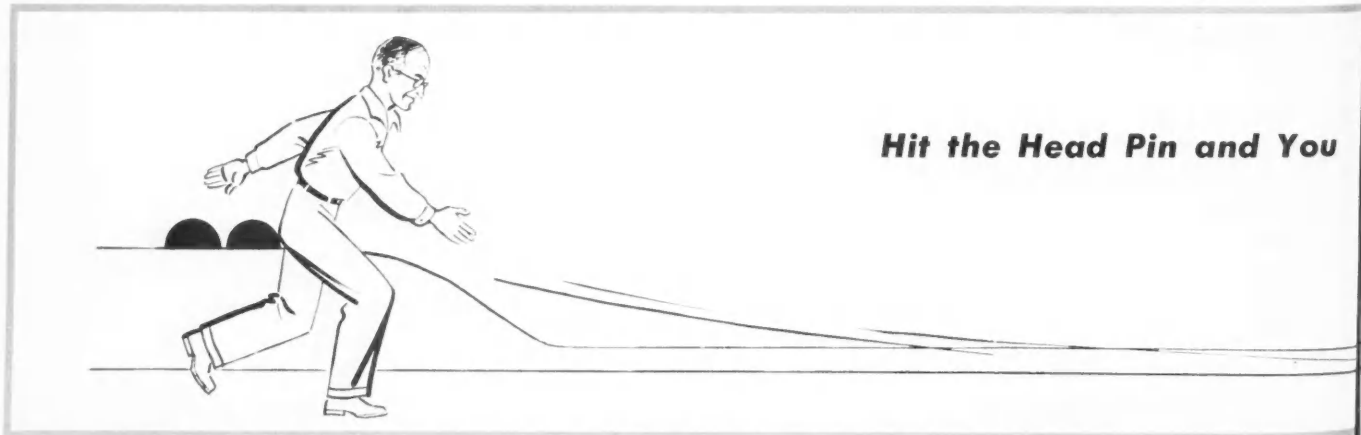
The administration attempted to divide the industry with the claim that the depletion allowance does not help the small operators. Depletion allowance, Snyder asserted, is of "little benefit to small prospectors on whose behalf it is so frequently supported." Likewise, claimed Treasury, the allowance generally does not aid the stripper producers.

The administration attempted to split the ranks of the allowance beneficiaries by asking no reduction in the percentage depletion for metals and coal. The nonmetallics are scheduled to be cut from 15 percent down to 5 percent and sulfur from 23 to 15, but metals with 15 and coal with 5 percent were unmolested.

If the metals and coal industries could be deceived by this hoary maneuver of splitting the opposition and pouncing on them one at a time, Treasury had struck a cunning blow.

Industry wheeled to the rebuttal with the alacrity of men whose footwork had been sharpened by long bouts with the tax collector. After robbing Treasury of some of the advantage of surprise, it closed ranks with emphatic spokesmen

■ CONTINUED ON PAGE 46



Hit the Head Pin and You

Depletion

Treasury's Proposal Would Have Global Repercussions

By ROBERT TULLY
The California Company, New Orleans

"I KNOW of no loophole in the tax laws so inequitable as the excessive depletion exemptions now enjoyed by oil and mining interests . . . In the case of oil and mining interests, however, the depletion exemption goes on and on, year after year, even though the original investment in the property has already been recovered tax free, not once but many times over."

In these words the President of the U. S. on January 23 launched the latest in a long series of attacks on allowable depletion, commonly known as percentage depletion. For the oil industry everywhere this is a matter of the gravest moment. Whatever action Congress takes on percentage depletion will have a far-reaching effect on U. S. oil companies and allied industries. Since these companies have their financial bases in the U. S., they will adjust their foreign operations to the changes at home. So it is that what appears to the public to be a minor technical change in the tax laws will have worldwide repercussions.

Yet, in spite of the importance of percentage depletion, it is a curious fact that there is a vast amount of misinformation and ignorance about it, both in the oil industry and in the government. The President's use of the word "loophole" is but the latest example of this. A loophole refers to a quirk or an oversight in the tax laws which permits certain taxpayers to reap an unexpected tax advantage. It usually is plugged as soon as Congress becomes aware of it. But the essential theory of percentage depletion has been a part of the tax laws for more than 30 years. It is a national policy which Congress adopted after due deliberation and has retained despite periodic attacks by the Treasury Department. Calling it a loophole is an example of the inaccurate thinking on this subject which has been all too common, both in the industry and in the government. An issue of such importance should be decided by clear thinking based on the facts of the situation. This involves a knowledge of what percentage depletion is, what its history is, and what the probable effects of a change in percentage depletion would be.

WHAT IS the percentage depletion? How does it work? What effect would a reduction have on the industry, the nation, and the world? WORLD OIL put these questions to Robert Tully, asking for a reply in the simplest possible language, sparing nor shielding friend or foe of the allowance, but hewing to the line and letting the chips fall where they may. His article, we believe, is such an enlightening analysis of a highly technical and controversial topic that WORLD OIL is sending reprints to members of the Congress. In the public interest, this magazine waives its copyright to this article. All or any part of it may be reproduced, with or without credit to WORLD OIL.

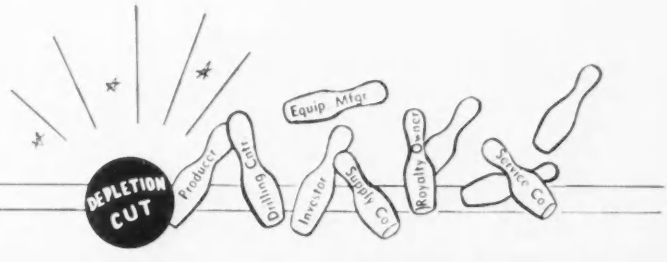
—The Editor

Percentage depletion permits the oil operator to deduct 27½ percent of his gross income from a particular property for tax purposes, but provides that he cannot deduct more than 50 percent of his net income. For example, an operator might have a total gross income of $1000 from one particular producing property. After making the usual deductions for operating expenses, etc., his net income might be $600. From this he would be allowed to deduct $275 (27½ percent of $1000) as a depletion allowance, so the income on which he would pay taxes would be $325. If, after making his usual deductions, this same operator had a net income of $400, his deduction for the depletion allowance would be limited to 50 percent of this amount or $200.

It is important to note that the operator must make his depletion calculations on a property-by-property basis. He cannot do it on an over-all basis, and thus is not allowed to offset an allowance on one property against another property on which his 27½ percent deduction did not come up to the 50 percent limit.

Because the history of percentage depletion bristles with terms such as "dis-

Hit Them All, Mr. Truman



covery value depletion," "cost depletion," and "return of capital in place," oil operators tend to be scared away from a study of the story of depletion. The tax accountant's jaron need frighten no one; the basic ideas behind the mouth-filling terms are easy to understand.

When the U. S. first adopted the income tax, it was recognized that a man should not be taxed on that part of his income which is a return of capital. For instance, a man who buys $1000 worth of toothpaste and sells it for $1500 should not have to pay tax on the entire $1500. Provision was made for him to deduct his capital outlay of $1000, plus his normal business expenses, from the $1500. Similarly, the man who puts up a factory to make toothpaste knows that eventually his factory will wear out; a little of it is "used up" in making each tube of toothpaste. Therefore, part of his income must be regarded as a return of the capital he invested in the factory. This part is, of course, known as depreciation and he is allowed to deduct it from his income for tax purposes. The man who discovers oil has invested his capital in the search and, when he "depletes" his underground reserves, he is using up his capital. Therefore, he, too, should be allowed to deduct from his income that part which is a return of his capital. In the case of oil and minerals, this is known as a depletion allowance.

Cost Depletion

The first income tax law provided that depletion should be calculated on a cost basis. If an operator invested $100,000 in a particular property, he was allowed to deduct so much for each barrel of oil he produced, the theory being that when the field was exhausted he would have had the $100,000 returned to him. Thus, if he discovered 1 million barrels, he would be allowed depletion of 10 cents a barrel. When the 1 million barrels were produced, he would have had his $100,000 capital investment returned to him, tax-free.

Discovery Value Depletion

Cost depletion had been in force only a short time when the U. S. entered World War I. The country faced a drastic shortage of oil and, in order to stimulate discovery and production, Congress in 1918 adopted what is known as discovery value depletion. Under this method, the fair market value of the oil 30 days after its discovery became the yardstick, although an operator could still use cost depletion, if he preferred. If the fair market value of 1 million barrels in the ground were $500,000, the operator was now allowed a deduction of 50 cents a barrel. The estimated number of barrels in the ground and the rate to be considered a fair market value now became of crucial importance and were the source of constant litigation.

Percentage Depletion

Disturbed by the problems of administering the law, Congress in 1926 searched for an easier method of calculating depletion. By analyzing the experience of a large number of oil companies, it found that the companies were being granted depletion allowances which averaged from about 25 percent to about 30 percent of their gross incomes. After some disagreement between the House and the Senate as to the exact percentage to be used, it was decided that 27½ percent of gross income, limited to 50 percent of net, should be the deduction allowed for depletion. This is percentage depletion as we know it today. It can readily be seen that percentage depletion is actually nothing more than a convenient method of calculating discovery value depletion, a method which produces approximately the same result as figuring it under the previous method and does so without causing endless litigation.

Over the years the Treasury has fought for at least a reduction in the percentage allowed and has been in favor of eliminating discovery value depletion (and its twin sister, percentage depletion) and requiring the use of cost depletion in all cases. The reason is obvious. In most cases, the market value of oil discovered is far greater than the costs of finding it. Therefore, the depletion allowance under the discovery value method is much larger and tax revenues are correspondingly lower.

Theory Attacked

In the past the Treasury has attacked discovery value depletion on theoretical grounds. The argument has usually run along the lines that an operator's actual monetary investment in a particular property is his capital investment in that property; therefore, the oil should be valued at that figure if one is to adhere to strict accounting theory.

In reply, the industry has made two major points. The first of these is that the Treasury's approach to depletion is exactly the same as its approach to depreciation, whereas the two are entirely separate concepts. Depreciation refers to an asset, such as a building, which can be replaced. Depletion, on the other hand, refers to an irreplaceable asset which is used up in the normal course of business. Over a period of years as price declines and advances cancel each other out, the businessman can reasonably hope that he will recover enough through depreciation to replace his assets as they wear out. The oil operator has no such hope. He knows that each oil field discovered means one less to be found and makes the next one that much more difficult to find. That means that each new field will cost more to find, on the average, than the last, a fact with which the oil industry is only too familiar. To stay in business, therefore, the oil operator must recover not only the cost of the field he has discovered but enough more to meet the cost of finding the ever more expensive fields of the future. This additional amount necessary to stay in business would seem to be a legitimate business expense which should be deductible for tax purposes. Discovery value depletion, as calculated by percentage depletion, offers a reasonable approximation of the amount which should be deducted.

The other major point the industry has made in reply to the Treasury's theoretical attack is that Congress has recognized that a single, rigid interpretation of accounting theory does not apply equally to all industries. Where special conditions have warranted it, Congress has made special provision for certain industries. The depletion exemptions simply recognize the extraordinary hazards of the oil industry—hazards which need not be spelled out for anyone in the industry.

The relative merits of the arguments on the question of theory may well be left to the theoreticians for the time being, however, since the Treasury now appears to be attacking not so much the theory as the size of the depletion allowance. As in the President's statement quoted above, the Treasury contends that an oil operator can, and often does,

About the Author

ROBERT TULLY majored in economics at Williams College, Williamstown, Mass., and in 1947 completed postgraduate studies at the Graduate School of Business Administration, Harvard University, for the degree of Master of Business Administration. He enlisted in the Army Signal Corps in 1942, was commissioned in 1943, and served in England and France during 1944. He was separated in 1946 with the rank of captain. In 1948 he joined the Finance department of The California Company at New Orleans.

recover his original investment in a property many times over, tax-free. This is undoubtedly true. The Treasury then states that this is inequitable and unfair, a statement which is at least open to question, and asks that the depletion allowance be reduced substantially (at the time this article is being written, it is understood that the Treasury has asked that percentage depletion be cut to 15 percent).

True Cost

It has already been pointed out that the ever-increasing cost of finding new fields, a cost which must be met in order to stay in business, would seem to be a legitimate expense, deductible for income tax purposes. In the long run, the money to meet this cost must come from fields already discovered. Therefore, an operator MUST recover more than his original investment in a field if he is to stay in business. Furthermore, the original investment in a property is not a true measure of the cost of the property. If a man leases 21 properties, drills dry holes on 20 of them, and finally strikes oil on the 21st, is the true cost of the 21st only the money spent directly on it? It would seem apparent that the true cost of the 21st includes the money spent on the 20 dry properties, and operator will have to recover many times the money spent on the 21st property before he recovers its true cost, including the money spent on the 20 dry holes. It should be realized that for tax purposes the operator could deduct most of the cost of the dry holes from any income he might have, and the Treasury has taken the position that this will enable him to recover the true cost of the property on which he was finally lucky. Therefore, says the Treasury, percentage depletion reimburses him over and above the true cost. The fallacy here lies in the assumption that he has income from which he can deduct the dry hole cost. The small independent, the shoestring prospector who today, as in the past, drills the majority of wildcats, has no such income or only a very small one. He knows that the only way he can recover his true cost is through a sizeable depletion allowance, one which allows him to recover far more than his actual investment in one particular producing property.

Practical Effects

What would be the practical effects of a decrease in percentage depletion? The oil operator knows it would cost him money in increased taxes, but that in itself is not an adequate reason to maintain percentage depletion as it is. The practical effects on exploration and discovery, on the total recovery of oil, on the small operator, on the Treasury's revenue, on the price of oil and its products, and on the investor should be the governing factors in Congress' decision on this matter. These effects will now be considered in turn.

How the Committee Stands

The House Ways and Means Committee is split over the Treasury's proposal to reduce the oil and gas industry's depletion allowance from 27½ percent to 15 percent. The following lineup of the committee members is indicated:

For Reduction	Against Reduction	Doubtful
Robert W. Kean (R., N. J.)	Hale Boggs (D., La.)	C. T. Curtis (R., Neb.)
A. J. Forand (D., R. I.)	J. M. Combs (D., Texas)	Hal Holmes (R., Wash.)
Jere Cooper (D., Tenn.)	N. M. Mason (R., Ill.)	A. L. Goodwin (R., Mass.)
R. L. Doughton (D., N. C.)	T. A. Jenkins (R., Ohio)	J. L. Dingell (D., Mich.)
J. A. Carroll (D., Colo.)	D. A. Reed (R., N. Y.)	N. J. Gregory (D., Ky.)
W. D. Mills (D., Ark.)	R. M. Simpson (R., Pa.)	A. S. Camp (D., Ga.)
	T. E. Martin (R., Ia.)	J. W. Byrnes (R., Wis.)
	R. O. Woodruff (R., Mich.)	W. A. Lynch (D., N. Y.)
		H. P. Eberharter (D., Pa.)

Thus, if only about four or five of the "doubtful" members of the committee voted against the Treasury's proposal, the depletion allowance would remain untouched. Some committeemen are expected to be influenced by the fact that on previous occasions—notably in 1942—the committee gave extended study to the same proposal and defeated it. Moreover, the committee members who are opposed to the change are especially well informed on the issue and active in their defense of the industry.

Many members of Congress not members of the Ways and Means Committee have expressed themselves opposed to reducing the depletion allowance, including Speaker of the House Sam Rayburn. As one Congressman said: "The Speaker's position would be worth a hundred votes on the House floor if the issue ever got out of committee and went to a floor fight."

Exploration and Discovery

● *Return on Investment.* More than 81 percent of the wildcats drilled in the U. S. in 1948 were dry and the money invested in them lost. In the face of such enormous risks, there would be little wildcat drilling if it were not for the high rate of return on a successful venture. The rate of return is, of course, influenced by the price of oil; if the price of oil goes up faster than the costs, the return is increased and wildcatting becomes more attractive. The Treasury has asserted that price is the sole determinant of the level of drilling activity and has assembled statistics showing, in general, that the higher the price, the higher the level of drilling activity. This will hardly be a surprise to anyone in the oil business. Increase the price and you increase the return, so the risk becomes more attractive and the drilling rate goes up. Conversely, cut the return and the risk becomes less attractive and drilling goes down. If percentage depletion were to be sharply reduced, the return would be decreased and so would wildcat operations.

In connection with the rate of return, it might be well to comment on the indignation with which some public officials, including the President, have greeted the news that some individuals in the oil business have amassed large fortunes. One of the reasons Congress adopted discovery value depletion and, later, percentage depletion was to provide a lure for venturesome individuals to risk their capital in the search for oil. The fact that a few people have succeeded in the search and reaped large rewards simply shows that the policy is working well.

The oil business might be compared to gambling with a slot machine. When we put a nickel in the machine, we know the odds are enormously against us, but we are willing to risk our nickel because, if we happen to be the lucky one out of the many who will put their nickels in, we will hit the jackpot and get an enormous return for our nickel.

Similarly, in the oil business hundreds and thousands of people are willing to risk their money because they know they might hit the jackpot which percentage depletion helps create. And they know there is such a jackpot because they hear of the individuals who have made large fortunes in oil. Instead of there being something wrong about people hitting

the jackpot, it is a positive necessity if we are to continue finding the oil we need. Further, for every one who hits the jackpot there are thousands in the industry who do not, as the author and most of those who read this article can testify from personal experience and a glance at their bank accounts.

● *Cash for Wildcats.* The amount of cash available after all other expenditures determines what can be spent on finding new oil. A decrease in percentage depletion would increase the cash paid to the government in taxes and leave less cash for exploration and wildcatting. This is particularly true of the small operator who gets the cash to finance his wildcats from the production of fields he has previously developed. He may have excellent wildcat prospects but he cannot drill unless he has the cash. A reduction in percentage depletion will cut his cash income and either delay or wipe out his drilling program.

● *Payout.* Oil companies figure their operations in terms of payout—how long it will take the income from a particular project to pay the cost of that project. Percentage depletion decreases the payout time when a new field is hit by increasing the net income from the field after taxes. A cut in the percentage would extend the payout and, in some cases, make the difference between paying out and not paying out. Knowing this, oil companies will feel reluctant about committing themselves to extensive wildcatting programs, feeling that the payout will be so far in the future as to increase the risk enormously.

● *Tax Advantage.* Many individuals and companies not in the oil business have participated in drilling ventures because of the tax advantage in doing so. Without a substantial tax incentive, to which percentage depletion contributes, it is doubtful if these companies and individuals would have undertaken these operations.

● *Historical Stimulus.* The history of the industry shows how well percentage depletion has fulfilled Congress' hopes in stimulating exploration and discovery. In World War I we could not satisfy our own requirements. In World War II we fueled ourselves and our allies and now have reserves of more than 27 billion barrels. Percentage depletion has been a major factor in stimulating the exploration which led to this record. But we must find more oil. Today we are using 5.7 million barrels of oil a day and the Bureau of Mines estimates that we will be using between 12.5 and 16 million barrels a day by 1975. At the same time, oil is getting steadily harder to find, with the result that more and more money must be spent to find a barrel of oil. In the face of an enormous increase in demand and skyrocketing costs, the wisdom of disturbing a tax structure which has helped the industry meet previous demands on it is open to serious question.

Recovery of Oil

To get all the oil possible from a field, the industry resorts to secondary recovery methods, which involve supplying external pressure or flushing agents to the reservoir to replace the gas pressure lost through production. Secondary recovery is an expensive proposition, requiring the drilling of injection wells and the construction of a plant. It is also a gamble because there is no assurance that it will work. A cut in percentage depletion will make the risk less attractive by reducing the return and may make it financially unsound by cutting the return to the point where it will not pay out. Small operators who finance secondary recovery through the cash they derive from their production will have less cash and may be unable to bear the cost.

With 20 billion barrels estimated to be recoverable through secondary recovery, it will be a national tragedy if these methods are not used to the fullest extent. Fields would be abandoned before the oil was fully recovered—once abandoned, a field can only rarely be brought back to production. In most fields the oil would be forever lost. A cut in percentage depletion would encourage this premature abandonment and waste.

Small Operator

● *Financing Original Wildcat.* The typical small operator gets his original wildcatting funds from individuals who put up a few thousand dollars apiece for a share in the venture, being stimulated to do so by the tax advantage in part. Reduce the tax advantage and the incentive for individuals to participate is reduced, making it harder for the small man to finance his operations.

● *Financing Development* Even after he makes a discovery, the small man has trouble getting funds. Banks rarely loan on the strength of a discovery well, usually demanding a proven producing field as security. So the small operator must again look to individuals with money to venture. Here again a reduction in the tax advantage will reduce the incentive to participate. There would be a strong tendency for the small operator, unable to interest venture capital in developing the field, to sell out to a major. A reduction in percentage depletion would probably be followed by an attack of "mergeritis."

● *Making Loan Payments.* A typical small operator lives in hope of making a big strike and becoming a big operator. He tends, therefore, to borrow to the limit on his proven production to get wildcatting money and does so in the belief that percentage depletion will help him meet the payments. A reduction in percentage depletion, reducing his cash available for loan payments, will work a real hardship on him and, in those cases where he is fully extended, may well wipe him out through inability to repay loans, particularly if a decrease in oil prices occurs at the same time.

● *Suppliers and Special Services.* Drilling operations support a host of allied industries: drilling contractors, tool and machine manufacturers, oil field supply houses, well logging services, etc. These are usually relatively small operations. Any cut in exploratory and development drilling resulting from a cut in percentage depletion will be a blow to these small businessmen.

● *Royalty Holders.* There are thousands of individual land owners throughout the country who receive royalty payments from oil production on their property and are allowed percentage depletion tax deductions. A cut in percentage depletion will hurt them directly.

Treasury Revenue

The Treasury has estimated that hundreds of millions of dollars in tax revenues are being lost through "excessive" depletion exemptions. Actually, however, much of the revenue which the Treasury regards as lost is being recovered. If the money made available by percentage depletion is used in operations it eventually finds its way into the hands of individuals and corporations as income and is taxed. If it is distributed as dividends, the stockholders are taxed on it.

More important is the long-term effect that a cut in percentage depletion will have on Treasury revenue. *A single major discovery, such as the North Synder Field in Scurry County, Texas, will produce more in revenue than is lost through depletion over the entire nation in any one year.* A cut in percentage depletion would discourage and delay the finding of new fields, thus causing a loss of revenue which would otherwise have been obtained. The effect will be cumulative over the years and it is probable that the net long-term result would be a decrease in the total revenue received by the Treasury.

Price

As exploration and discovery lag because of a cut in percentage depletion, reserves will drop and oil will become scarcer, eventually causing a price rise. An increased price is a two-edged sword. It would mitigate some of the shocks to the industry previously discussed but only after a long and painful readjustment period, and it would not compensate for the reserves forever lost or the small men forced out of business. It would have a train of undesirable conse-

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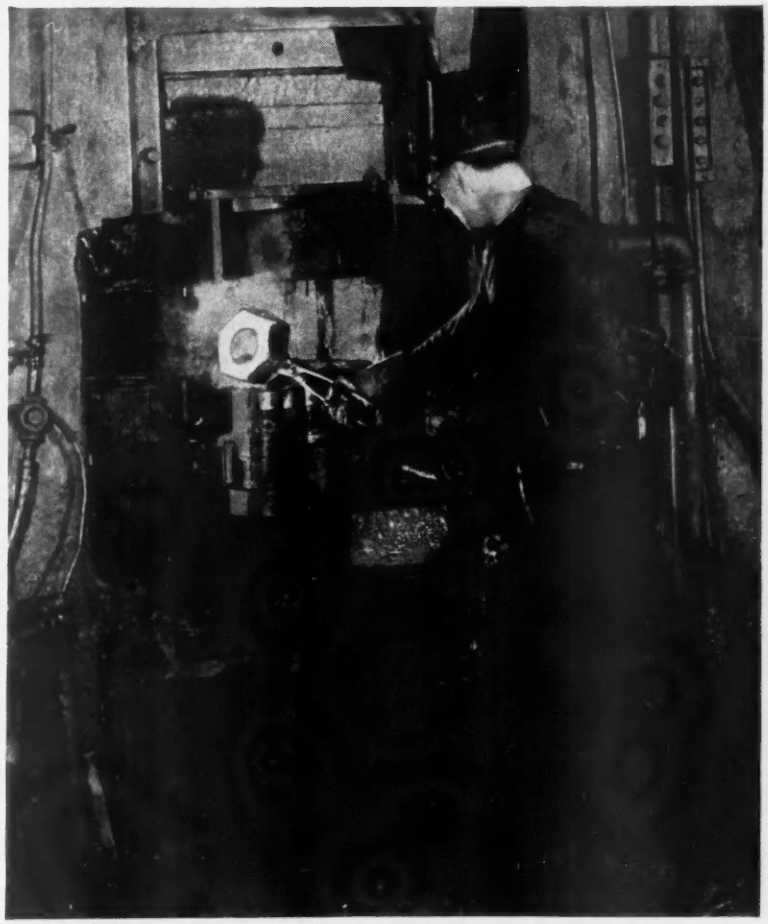

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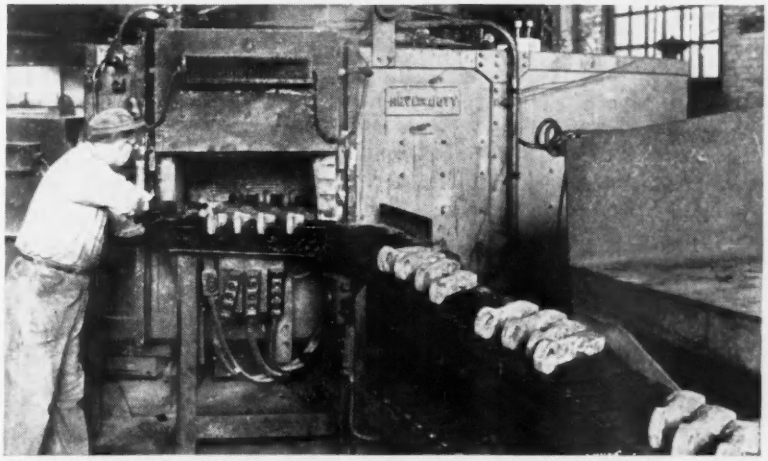

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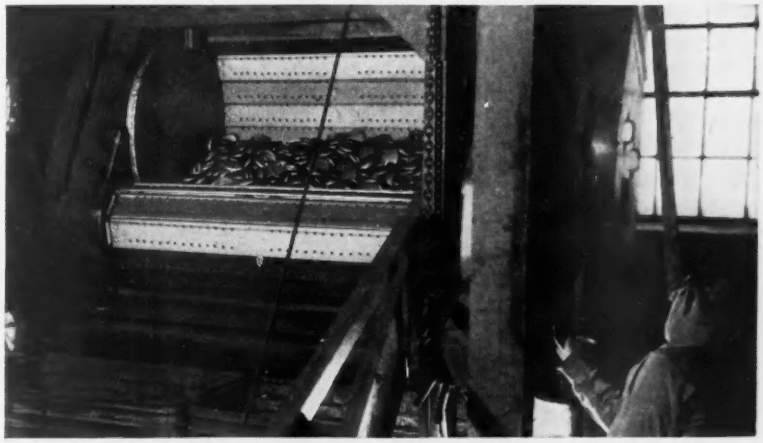

Shot-blasting an order of drop forgings prior to inspection.

quences. The consumer would be hurt. The pressure to import foreign oil would be greatly increased. Most important, perhaps, would be the general public's attitude toward the industry.

We live in a price-conscious society. Any increase in price usually results in cries of "excessive profits," "gouging the public," "monopoly," etc., with overtones of industry nationalization. The industry's answer, of course, would be to point to the scarcity of oil and the necessity of a high price to encourage finding more. It requires little imagination to foresee the charges that the industry had fallen down on its job and that the government must take a hand in the name of national defense and heating the American home.

Investor

The oil industry is owned by small people, the thousands of individual stockholders and the independent operators. A cut in depletion will reduce the earnings after taxes on their investments. Since earnings determine the value of their holdings, a portion of their savings will be wiped out as earnings fall.

Discovery value or percentage depletion has been in effect for more than 30 years. The oil industry constructed a vast plant, valued at billions, during those years, a plant which has served the country well in war and peace. This plant was built under payout calculations based on discovery value depletion and percentage depletion. Congress steadfastly upheld percentage depletion and the industry felt it could safely construct its plant, large portions of which would never have been built without the stimulus of percentage depletion. To cut percentage depletion now would be breaking faith with the industry. It may be argued that this is a normal business risk, but that is small comfort to the man who has a plant which he knows will not pay out if his depletion exemptions are cut.

Conclusion

No one can predict with absolute certainty what the effects of a particular governmental action will be. Subsequent events are obscured by the shifting tides of economic fortune and it is usually impossible to determine whether the predictions were correct. In the present case, that is particularly true. The author has endeavored to restrict his comments to those areas in which it has seemed to him that the results of a cut in percentage depletion are reasonably predictable. The oil industry will not, of course, go under if a cut becomes law, but it will undergo marked changes. If the author's analysis is correct, these changes would be unfortunate from the viewpoint of both the industry and the nation.

Percentage Depletion

■ CONTINUED FROM PAGE 40

for the small prospectors and the stripper well operators.

Roland V. Rodman, president of Anderson - Prichard Oil Corporation, told the committee that small oil companies and operators, who account for a substantial part of the industry's new discoveries but who depend on percentage depletion to recoup capital lost on unsuccessful ventures, would be forced out of business.

(See Table 1 for figures compiled by J. S. Bridwell, Bridwell Oil Company, Wichita Falls, who was asked by WORLD OIL to compare the performance of a lease under the present law with its performance under the Treasury's proposal.)

F. L. Hurley of the East Texas Chamber of Commerce said that millions of dollars have been loaned to independent producers on the assumption that 27½ percent depletion allowance would be retained. To reduce this allowance would cause bankruptcy among a great many independent producers.

J. P. Jones, president of the National Stripper Well Association, testified that "The proposed recommendation of the Treasury Department jeopardizes the only fund available that will enable him (the stripper well operator) to continue his operation and expand his activity if he is to stay in business."

Then the industry turned from rebuttal to the counter-attack, moving up a mass of evidence that emphasized these points:

- A reduction in the allowance would be a threat to national security. General Ernest O. Thompson, senior member of the Texas Railroad Commission, told the committee: "But for the depletion incentive, the U. S. could not have oiled World War II. The reasons which prompted Congress in 1918, 1926 and again in 1942 to retain the 27½ percent depletion allowance apply all the stronger today. We do not have enough oil to fight another war."
- A reduction in the allowance would be especially hurtful to the deep wildcatting which is becoming more necessary as shallow areas become fully explored. B. A. Hardey, Shreveport independent, pointed out that a 10,000-foot well costs about ten times as much as a 2500-foot well, although only four times as deep.
- A reduction would upset the fiscal programs in virtually every oil - producing state. This would give rise to unemployment, to relieve which the government would spend more than it gained from the allowance reduction. Oklahoma Governor Roy J. Turner said 60 percent of the state's revenue is derived from oil industry taxes and that a loss in this revenue would place a direct burden on the individual taxpayer and would mean a complete breakdown of the tax structure that supports the Oklahoma government.
- A reduction would mean higher consumer prices. Hardey told the committee that ". . . prices on petroleum products would have to increase by about $350 million if the industry is to realize the same net income after taxes as it does on the present volume at existing rates."
- An allowance reduction would increase the perils of an already risky business. Rodman showed how the element of risk in oil hunting has increased. The percent of dry holes to total wells drilled in 1937 was 24.2 percent, but it was 35.9 percent by 1948.
- A reduction in the depletion allowance would NOT increase government revenues. R. B. Anderson of Vernon, Texas, who represented the Texas State School Board, said that "the slackening of operations which will result (from an allowance reduction) will be felt clear back through the allied industries. This, in turn, will affect future tax revenue."
- Percentage allowance for the major operator is no "loophole" but is vital to the U. S. oil economy. The industry struck hard on this point. Frank M. Porter, president of the Mid-Continent Oil & Gas Association declared:

"The percentage depletion allowance is an essential incentive for the large operators to assume these risks of exploring new areas where the costs are far beyond the scope of individual operators and small companies because one or two failures on the large risks would bankrupt the small operators. It is because of these circumstances that the large companies need the same rate of depletion that the small ones do. Any discrimination between producers according to size would not only result in a general diminishment but would amount to a deliberate handicap on the exploration and development in expensive new areas."

TABLE 1

PRESENT BASIS		
Income	$180,000	@ 27½% = $49,500
Development Costs	90,000	
	$ 90,000	
Operating Costs	10,000	
Net Operating Profit	$ 80,000	(50% = $40,000)
Depletion Allowed	40,000	
Taxable Profit	$ 40,000	
PROPOSED BASIS		
Income	$180,000	
Development Costs	90,000	
	$ 90,000	@ 15% = $13,500
Operating Costs	10,000	
Net Operating Profit	$ 80,000	(50% = $40,000)
Depletion Allowed	13,500	
Taxable Profit	$ 66,500	

Since the operator had a loss of $50,000 for unproductive wildcatting, lease forfeitures, etc., the depletion allowance in each instance was not sufficient to cover other non-profitable ventures.

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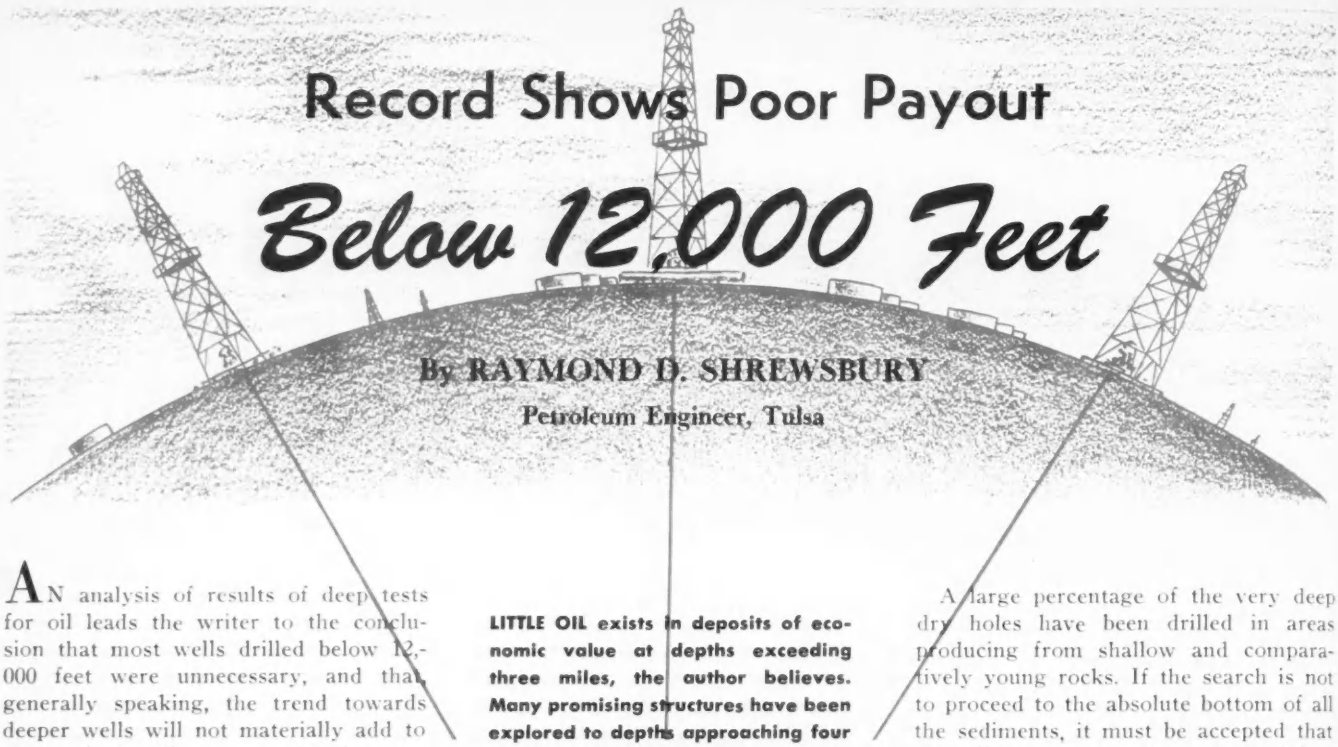

By RAYMOND D. SHREWSBURY

Petroleum Engineer, Tulsa

LITTLE OIL exists in deposits of economic value at depths exceeding three miles, the author believes. Many promising structures have been explored to depths approaching four miles with almost consistently negative results. The major portion of all the oil ever discovered still remains underground and less than a mile deep. Percentage of recovery has been small because of low temperatures and pressures and high viscosities. Use of hydrogen to convert these "lost" oils into recoverable liquid hydrocarbons is a logical goal.

AN analysis of results of deep tests for oil leads the writer to the conclusion that most wells drilled below 12,000 feet were unnecessary, and that, generally speaking, the trend towards deeper wells will not materially add to the nation's oil reserves. During the dozen years since the first 12,000-foot hole was drilled in search of petroleum, many promising structures have been explored to depths approaching four miles with almost consistently negative results.

More than 600 exploratory holes have passed the 12,000-foot mark. About 30 of these are classed as successful, but not more than ten appear to justify additional drilling in their respective areas. No such record of failure has previously met the steadily increasing depth range of drilling equipment.

It is frequently claimed, in connection with the drilling of some very deep tests, that the geological information obtained justifies the cost. Because of the intense interest aroused by such operations it seems highly improbable that secrecy could be maintained regarding any really important findings. On a straight basis of reported successes and failures of these ventures it must be accepted that the deeper sediments are far less rich in oil than those at shallower depths. Nothing resembling the gusher type of production that characterized early oil development has been found below the two-mile depth.

A popular belief persists that, in favored areas and at still greater depths, immense oil deposits will be found. This notion is encouraged by the more commonly accepted theories regarding the origin, migration, and accumulation of petroleum. These theories have not contributed materially to the finding of more oil and to the extent that they conflict with actual facts they should be considered "with a grain of salt."

Before proposing a new, or modified, theory it is well to examine the older theories to determine the fallacies inherent therein and which should be corrected.

After instruments were devised for determining true bottom hole conditions it appeared that the richness of producing zones was proportional to the temperatures and pressures existing within the formation. Both of these factors being intensified with depth, it was logical to assume that a sort of natural distillation process was responsible for petroleum and its characteristics. Great thicknesses of sediments that had originally contained the basic raw materials could therefore be expected to contain oil and gas in increasing quantities to indefinite depths. Such reasoning has led to the search for petroleum in deeply buried formations that are known to be productive at shallower depths elsewhere. The notion is closely akin to the old and, in the writer's opinion, thoroughly discredited idea that no oil of consequence could ever be found in any formation younger than the Pennsylvanian. Most of the failures cited have succeeded in reaching their objectives. If the oil isn't there, it has obviously escaped.

A large percentage of the very deep dry holes have been drilled in areas producing from shallow and comparatively young rocks. If the search is not to proceed to the absolute bottom of all the sediments, it must be accepted that the oil has moved from its original placement into the overlying beds.

Both the organic and inorganic theories of the origin of oil, as generally propounded and accepted, seem content with getting the compound manufactured, so to speak. Its disposal thereafter is left to other more or less undesignated natural forces. It is proposed that the natural agency responsible for the existence of oil and gas in the first place is also competent to cause their migration and accumulation. Free hydrogen, arising from below, satisfies these requirements.

According to the organic theory, the quantities of petroleum existing in rocks of various ages is dependent upon the profusion of life during the periods when the sediments were laid down. The criteria of abundance, or scarcity, are the quantities of oil and/or coal in the deposits. Such reasoning is unsound but it constitutes the only basis for expecting oil to be found in the deeper horizons. Another tenet of the theory is that the sediments are subjected to specific degrees of pressures and temperatures to form petroleum. Oil is found in areas where the required conditions cannot be determined ever to have existed. The theory also fails to explain the source of sufficient hydrogen to form natural hydrocarbons.

"Inorganic origin" is a catch phrase. The component elements of petroleum, like those of all other earth matter, have necessarily been present, on or in, the earth since its beginning. Since all earth material originally derived from outer space, it is equally valid to consider oil as of cosmic origin.

It is possible to produce substances closely resembling crude oil from inorganic material. To deny, however, that organic processes have had anything to do with the occurrence of petroleum is to ignore the fact that none has been found in any of the rocks antedating the beginnings of life on the planet. If the constituents and conditions suitable for the occurrence of oil existed during the first 2 or 3 billion years, why was none formed prior to the last 500 million?

The single point of agreement between the organic and inorganic theories seems to be the assurance that oil in abundance will be found at very great depths. The expenditure of vast sums of money and great effort has failed to validate this premise. A compromise theory, incorporating the acceptable features of both the others but eliminating those concepts that are incompatible with newly ascertained facts, is indicated.

Any logical approach to this problem must take into consideration the physical properties of the two essential components of petroleum.

Hydrogen is the lightest and simplest in atomic structure, of all the elements. In its free state at depth and under all conditions of heat and pressure, it is a gas. In quantity it is not available in the lower atmosphere for combination with other matter.

Carbon is approximately twice as heavy as water. It is an essential ingredient of all organic materials and is unique in possessing a practically unlimited affinity for the element hydrogen.

That oil forms within the sediments, on or under the ocean floor, seems certain. The only probable source of free hydrogen under the seas is the earth's interior. Carbon, as a component of organic debris, is deposited on the sea bottoms and is thereafter converted to petroleum.

Oil floats. If the complete transformation from the basic materials to the lighter hydrocarbons took place in the upper, unconsolidated sediments of the ocean floor, the oil would immediately rise to the surface and be dissipated.

The alternative to quick conversion is a slow transformation dependent upon the continuous availability of hydrogen from below. Every atom of the gas that nears the surface has escaped from the earth's interior magma and passed upward through the entire column of sediments.

That hydrogen exudes from the interior is a basic principle of the cosmic theory of the origin of petroleum. This theory assumes, however, that the gas escapes through faults and fissures. If this were true the gas could not come into intimate contact with the carbonaceous materials contained in the rocks. The existance of seams and veins in severely faulted rocks demonstrates that fractures resulting from earth movements are normally soon closed by the deposition of mineral matter from meteoric waters. Such deposits are invariably less permeable than the containing sediments. Any escaping hydrogen would be diverted through the pores of the rocks.

About the Author

RAYMOND D. SHREWSBURY graduated from the University of Pittsburgh with a B.S. degree in petroleum engineering and has been engaged in the oil industry in the U. S. and abroad for about 35 years. Before entering the consulting field he was affiliated with a number of major oil and service companies and worked in every major subdivision of the nation's oil territory as well as in Canada and South America. He resides in Tulsa.

Hydrogen passes readily through practically all sedimentary rocks. On its way surfaceward it naturally seeks the line of least resistance. When and if it combines with any other element the resulting substance becomes more viscous than the parent gas. Some rock pores may thus be closed until sufficient additional hydrogen has been absorbed by the new material to render it fluid or gaseous to the extent that it too will move upward. Thus oil and gas are formed.

Carbon as a component of all organic debris is distributed and buried with the other sediments of the ocean floor. The only hydrogen it may thereafter encounter is through that rising through all of the underlying beds. When or where the conversion to oil occurs is dependent primarily upon the abundance of either or both of the combining elements. The carbon could not have been available in a suitable state or condition until it has at least once passed through some organic process. Hydrogen has no doubt been exuding from the interior of the earth since the genesis of the planet. It is among the most abundant of all the elements.

It is the normal fate of all organic residue to be eventually buried in the sediments. Yet contemporary life subsists upon the debris of the dead past. It is interesting to speculate upon the probable consequences to life itself had there not existed a natural process by which vital substances are returned to the surface for re-use. Through the operation of this life-preserving process petroleum is formed.

Metamorphism is the nemesis of petroleum. At or near the surface the oil content of any formation declines in proportion to its proximity to a metamorphosed region. No oil man would expect to find oil within a metamorphosed area and the negative effect usually extends laterally for scores of miles. This is an aspect apparently ignored by those who anticipate the discovery of great oil deposits several miles deep. The internal structure of any rock is modified in direct proportion to the imposed pressure. Elastic limits vary, but suitable reservoir rocks are notoriously incompetent. The pressures and temperatures required to cause permanent distortion of most sedimentary rocks are universally present at relatively shallow depths. The rather abrupt intensification of drilling difficulties generally encountered at about 12,000 feet may indicate that metamorphism is incipient at approximately that depth. If this is true the prospects of finding any significant quantity of oil below that depth decline accordingly.

Some may construe the above as contradicting the theory of upward migrating hydrogen. However, if some lighter substance did not permeate all the strata to indefinite depths there would no doubt exist a definite line of demarcation between the overstressed and understressed rocks. Seismograph could easily locate such a division. Its nonexistence indicates the presence of some agency capable of maintaining the sediments in a state of agitation. Only the presence of a gas which will not liquefy under tremendous pressure can account for such a condition. Heaving shales are one manifestation of unstable underground conditions.

If hydrogen is continually rising from below and purging the sediments of whatever organic matter is encountered it follows that only a small percent of the petroleum manufactured by nature ever becomes entrapped. All but a minor portion escapes to the surface and is dissipated. Oil, in moderate quantities, does not destroy vegetation and even in larger amounts is not permanently detrimental to plant growth. Much of the organic matter in particularly fertile soil may be dry petroleum residue.

Deeper formations have been subjected for longer periods to the purging action of hydrogen. The petroleum remaining at great depths consists of those fractions containing so little carbon that

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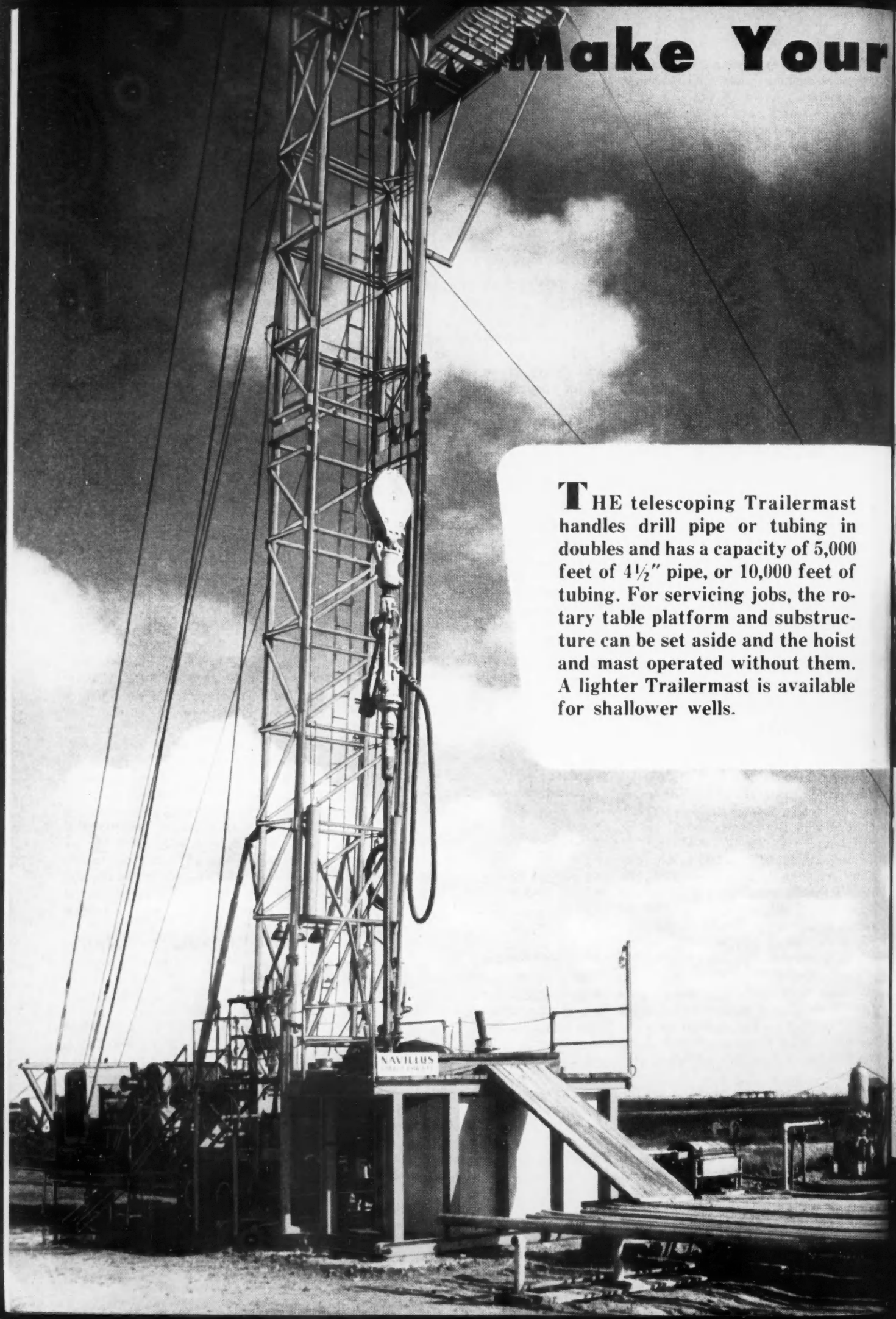

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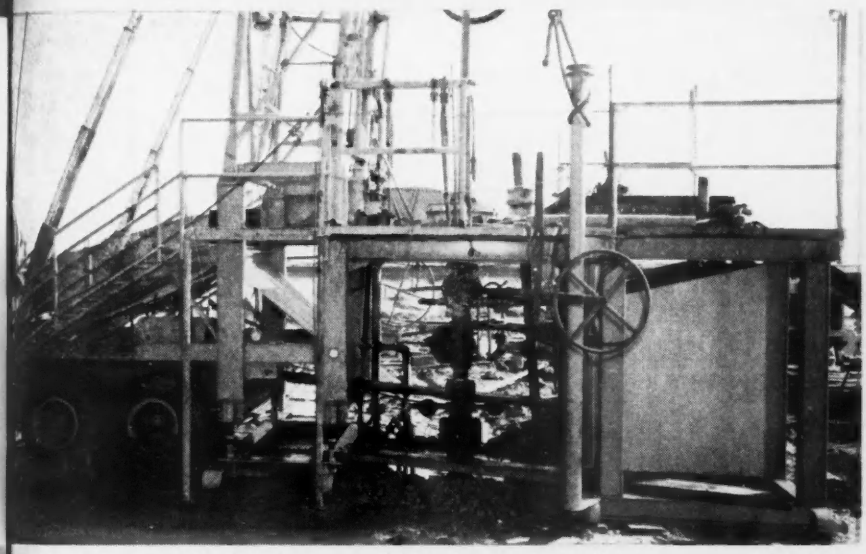
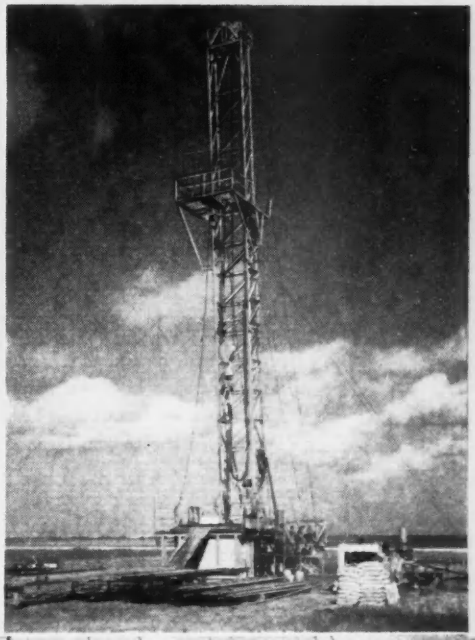


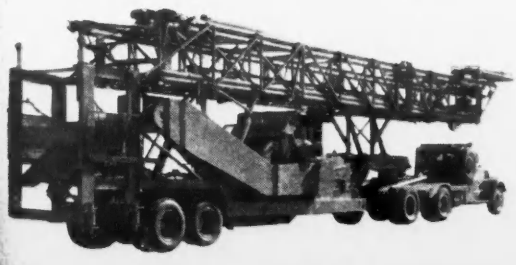
The 16' x 16' derrick floor provides plenty of working space and is high enough for blowout preventers and wellhead connections. Note optional location of doghouse.

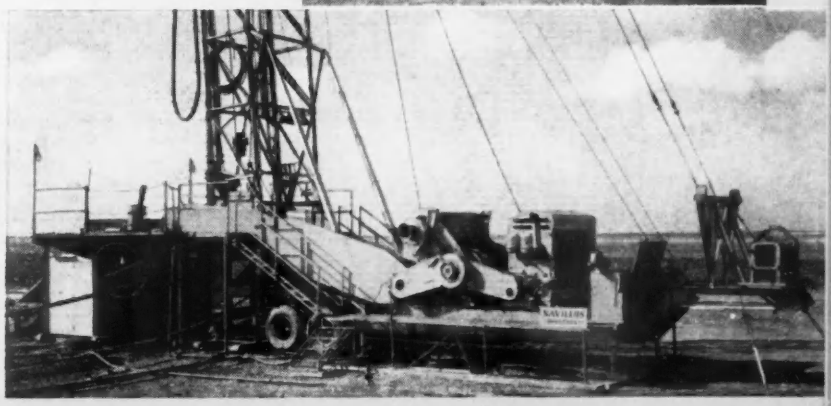
Mast is erected with built-in hydraulic system and raised to full height with traveling block and drilling line. The rig is usually ready for work in less than three hours.



Any "Cardwell" single engine rig is mounted on the Trailermast frame and can be removed for operation under conventional derrick. Note convenient walkways and built-in rathole digger.

Trailermast with draw works in place is quickly moved with a three- to five-ton truck tractor.





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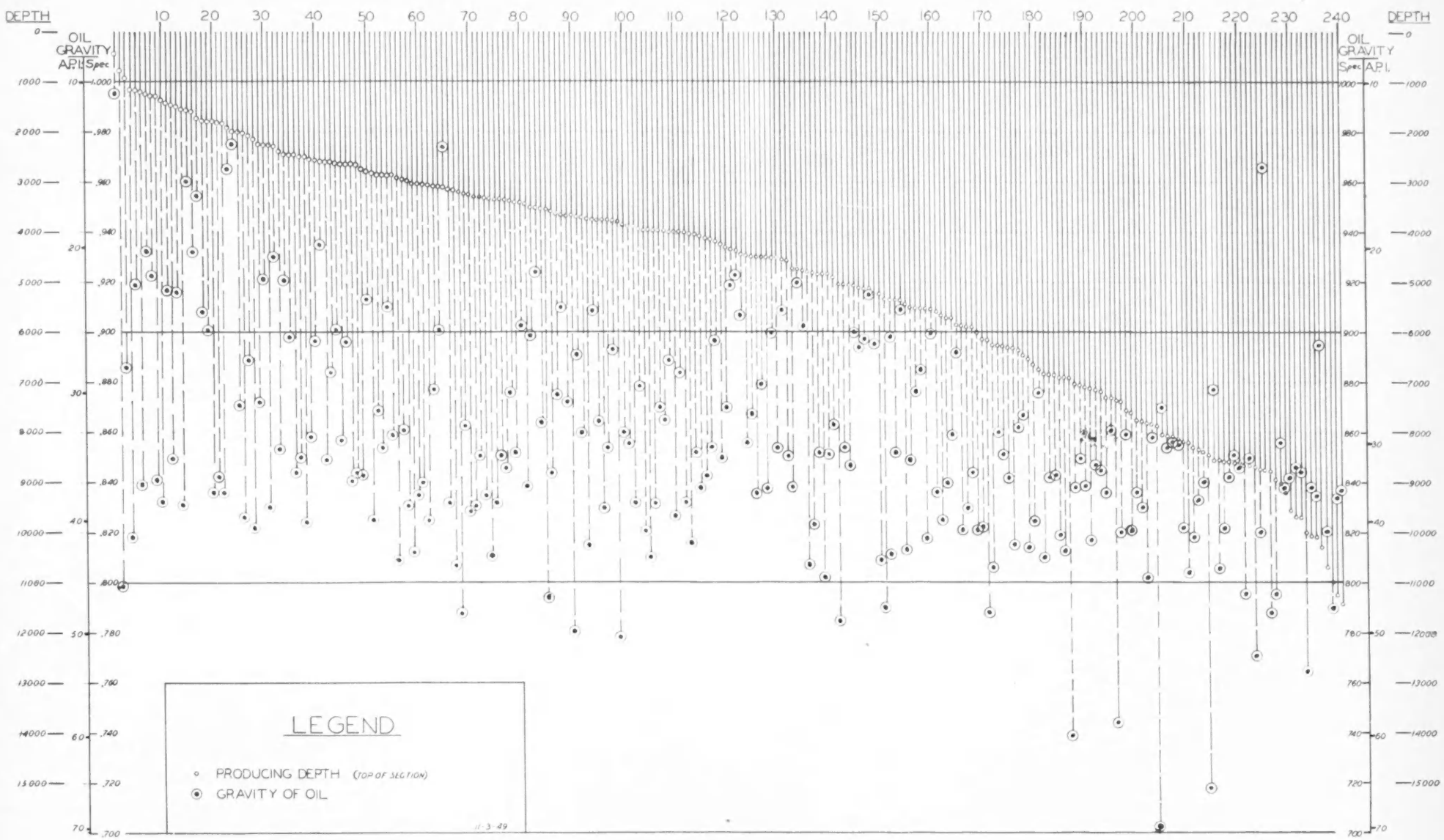

This is the index to the 240 oil fields shown on the chart. To find the information on the chart corresponding to a particular field count the vertical lines from left to right until the number of

This is the index to the 240 oil fields shown on the chart. To find the information on the chart corresponding to a particular field count the vertical lines from left to right until the number of the field as shown in the index is reached.

Chart No.	Depth	FIELD NAME	State	GRAVITY Specific	GRAVITY A.P.I.
1	450	Kern River	Cal.	.995	14.1
2	775	Grass Creek	Wyo.	.798	45.8
3	920	Velma	Okla.	.886	28.2
4	1,165	Alleganey	N. Y.	.818	41.5
5	1,175	Round Mountain	Cal.	.919	22.5
6	1,199	Centralia	Ill.	.839	37.2
7	1,251	Van	Texas	.932	20.3
8	1,280	Capitan	Cal.	.922	22.0
9	1,300	Lake Verret	La.	.841	36.8
10	1,378	Patoka	Ill.	.832	38.6
11	1,400	Anse la Butte	La.	.917	22.8
12	1,485	Mt. Carmel	Ill.	.848	35.4
13	1,500	Santa Maria-Orcutt	Cal.	.916	23.0
14	1,550	Loudon	Ill.	.831	38.8
15	1,577	Edison	Cal.	.960	15.9
16	1,600	Midway-Sunset	Cal.	.932	20.3
17	1,748	Mount Poso	Cal.	.954	16.8
18	1,794	Government Wells, N.	Texas	.908	24.3
19	1,800	McCamey	Texas	.901	25.6
20	1,800	Anse la Butte	La.	.836	37.8
21	1,814	Poole	Ky.	.842	36.6
22	1,834	Uniontown	Ky.	.836	37.8
23	1,909	Kern Front	Cal.	.965	15.1
24	2,000	Gato Ridge	Cal.	.974	13.8
25	2,000	West Cote Blanche Bay	La.	.871	31.0
26	2,024	Boyd	Ill.	.828	39.4
27	2,085	Luling-Branyon	Texas	.889	27.7
28	2,163	Caddo Dist.	La.	.822	40.6
29	2,263	Olla	La.	.872	30.8
30	2,269	Tatums	Okla.	.921	22.1
31	2,277	Hall-Gurney	Kans.	.830	39.0
32	2,300	Coalinga, East	Cal.	.930	20.7
33	2,406	El Dorado	Kans.	.853	34.4
34	2,450	Seven Sisters	Texas	.921	22.1
35	2,462	Hamilton Dome	Wyo.	.898	26.1
36	2,463	Salt Creek	Wyo.	.844	36.2
37	2,507	Griffin	Ind.	.845	36.0
38	2,552	Cushing	Okla.	.824	40.7
39	2,570	Salt Creek	Wyo.	.859	33.2
40	2,575	Tussy	Okla.	.897	26.3
41	2,587	Smackover (Norphlet)	Ark.	.935	19.8
42	2,600	Ward, North	Texas	.849	35.2
43	2,600	Frannie	Wyo.	.884	28.6
44	2,612	Tussy	Okla.	.901	25.6
45	2,638	Glenpool	Okla.	.857	33.6
46	2,650	Hoffman	Texas	.894	26.8
47	2,650	Darst Creek	Texas	.841	36.8
48	2,670	Loco Hills	N. M.	.842	36.6
49	2,760	Lone Grove	Okla.	.843	36.4
50	2,800	Loma Novia	Texas	.913	23.5
51	2,813	Bible Grove	Ill.	.825	40.0
52	2,815	McElroy	Texas	.869	31.3
53	2,836	Deep River	Mich.	.854	34.2
54	2,880	Howard-Glasscock	Texas	.910	24.0
55	2,882	Adams	Mich.	.859	33.2
56	2,941	Bloomer	Kans.	.809	43.4
57	2,966	Van	Texas	.861	32.8
58	2,994	Clay City	Ill.	.831	38.8
59	3,022	Silica	Kans.	.812	42.8
60	3,052	Burnett	Kans.	.835	38.0
61	3,060	Gorham	Texas	.840	37.0
62	3,060	Dale-Hoodville	Ill.	.825	40.0
63	3,100	Rincon	Cal.	.877	29.9
64	3,109	Wilmington	Cal.	.901	25.6
65	3,120	Torrence	Cal.	.974	13.8
66	3,180	Genesco	Kans.	.832	38.6
67	3,182	St. Lewis Dist.	Okla.	.807	42.8
68	3,208	Chase	Kans.	.788	48.1
69	3,250	Burrton	Kans.	.863	32.5
70	3,282	Trapp	Kans.	.829	39.2
71	3,305	Apache	Okla.	.831	38.8
72	3,325	Barnhold	Kans.	.851	34.8
73	3,329	Elwood-Goleta	Cal.	.835	38.0
74	3,341	Kraft-Prusa	Kans.	.811	43.0
75	3,352	Stoltenberg	Kans.	.832	38.6
76	3,362	Langlie-Mattix	N.M.	.851	34.8
77	3,367	Bemis-Shutts	Kans.	.846	35.8
78	3,400	Lake St. John	La.	.876	30.0
79	3,407	Jordan	Texas	.852	34.6
80	3,425	Byron	Wyo.	.903	25.2
81	3,442	Grayburg-Jackson	N. M.	.839	37.2
82	3,505	Greta	Texas	.899	25.9
83	3,525	Oregon Basin	Wyo.	.922	22.0
84	3,543	Ray	Kans.	.864	32.3
85	3,574	Reed City	Mich.	.796	46.3
86	3,603	Penrose-Skelly	N. M.	.844	36.2
87	3,650	Stephens-Smart	Ark.	.875	30.2
88	3,675	Refugio	Texas	.910	24.0
89	3,678	Penwell	Texas	.872	30.8
90	3,692	Coldwater	Mich.	.781	49.7
91	3,711	Morel	Kans.	.891	27.3
92	3,750	Domingues	Cal.	.860	33.0
93	3,753	Zenith-Peace Creek	Kans.	.815	42.1
94	3,754	Fruitvale	Cal.	.909	24.2
95	3,755	Hull	Texas	.865	32.1
96	3,770	Fitts	Okla.	.830	39.0
97	3,785	Arrowhead	N. M.	.854	34.2
98	3,790	Iberia	La.	.913	23.5
99	3,820	Fork	Mich.	.779	50.1
100	3,857	Cowden, South	Texas	.860	33.0
101	3,886	Eunice	N. M.	.856	33.8
102	3,900	Jacalitos	Cal.	.832	38.6
103	3,942	Lost Soldier	Wyo.	.879	29.5
104	3,964	Bowlegs	Okla.	.821	40.9
105	3,988	Nebo-Hemphill	La.	.810	43.2
106	3,990	Maljamar	N. M.	.832	38.6
107	3,991	Racoon Bend	Texas	.870	31.1
108	3,996	Monument	N. M.	.865	32.1
109	4,014	Gueydan	La.	.889	27.7
110	4,017	Little River	Okla.	.827	39.6
111	4,017	South Houston	Texas	.904	25.0
112	4,020	Seminole City	Okla.	.832	38.6
113	4,028	Pauls Valley	Okla.	.816	41.9
114	4,078	Hobbs	N. M.	.852	34.6
115	4,080	St. Louis Dist.	Okla.	.838	37.4
116	4,140	Foster	Texas	.843	36.4
117	4,175	Goldsmith	Texas	.854	34.2
118	4,200	Saxet	Texas	.897	26.3
119	4,265	Cowden, North	Texas	.850	35.0
120	4,355	Fannett	Texas	.870	31.1
121	4,367	Fuhrman-Mascho	Texas	.919	22.5
122	4,376	McFaddin	Texas	.923	21.8
123	4,465	Sulphur Bluff	Texas	.907	24.5
124	4,480	Garden Island Bay	La.	.836	37.8
125	4,492	Elk Basin	Wyo.	.868	31.5
126	4,500	Rosecrans-Athens	Cal.	.836	37.8
127	4,500	Means	Texas	.880	29.3
128	4,502	Vacuum	N. M.	.838	37.4
129	4,518	Heidelberg	Miss.	.900	25.7
130	4,530	Tom O'Connor	Texas	.854	34.2
131	4,570	Seal Beach	Cal.	.909	24.2
132	4,588	Haynesville	La.	.851	34.8
133	4,731	Walnut Bend	Texas	.838	37.4
134	4,769	Long Beach	Cal.	.920	22.3
133	4,773	Placedo	Texas	.903	25.2
136	4,800	Benavides	Texas	.807	43.8
137	4,836	Pickens	Miss.	.823	40.4
138	4,842	Tinsley	Miss.	.852	34.6
139	4,843	Sun	Texas	.802	44.9
140	4,857	Cumberland	Okla.	.851	34.8
141	4,908	Vinton	La.	.863	32.5
142	5,052	Luby	Texas	.785	48.8
143	5,080	Wasson	Texas	.854	34.2
144	5,084	Seminole	Texas	.847	35.6
145	5,087	Raisin City	Cal.	.900	25.7
146	5,107	Manvel	Texas	.894	26.7
147	5,137	Thompson	Texas	.897	26.1
148	5,141	Eucutta	Miss.	.915	23.1
149	5,240	High Island	Texas	.895	26.6
150	5,247	Long Lake	Texas	.809	43.4
151	5,344	Lance Creek	Wyo.	.810	43.2
152	5,350	Withers, North	Texas	.898	26.1
153	5,362	Refugio	Texas	.851	34.8
154	5,365	Aliso Canyon	Cal.	.909	24.2
155	5,457	Belridge, North	Cal.	.813	42.6
156	5,505	Rangley	Colo.	.849	35.2
157	5,505	Mountain View	Cal.	.876	30.0
158	5,506	West Columbia	Texas	.885	28.4
159	5,535	Tomball	Texas	.817	41.7
160	5,540	Magnet-Withers	Texas	.899	25.9
161	5,600	Golden Meadow	La.	.836	37.8
162	5,691	Todd	Texas	.825	40.0
163	5,718	Heyser	Texas	.840	37.0
164	5,750	Del Valle	Cal.	.859	33.2
165	5,850	Clear Lake	Texas	.892	27.1
166	5,880	Cranfield	Miss.	.821	40.9
167	5,898	Plymouth	Texas	.830	39.0
168	5,900	White Lake, East	La.	.844	36.2
169	6,000	Seeligson	Texas	.821	40.9
170	6,120	Crescent	Okla.	.822	40.6
171	6,179	McFaddin	Texas	.788	48.1
172	6,258	Quitman	Texas	.806	44.1
173	6,260	West Bay	La.	.860	33.0
174	6,285	Cement	Okla.	.871	31.0
175	6,304	Midway	Ark.	.842	36.6
176	6,312	La Rosa	Texas	.815	42.1
177	6,385	Newhall-Poterero	Cal.	.862	32.7
178	6,472	San Miguelito	Cal.	.867	31.7
179	6,533	Antioch	Okla.	.814	42.3
180	6,662	Riverdale	Cal.	.825	40.0
181	6,768	Amelia	Texas	.876	30.0
182	6,810	Fullerton	Texas	.810	43.2
183	6,844	Caillou Island	La.	.842	36.6
184	6,845	Fairbanks	Texas	.843	36.4
185	6,895	Iowa	La.	.819	41.3
186	6,901	Silsbee	Texas	.813	42.6
187	6,914	Saxet	Texas	.739	60.0
188	7,044	Anahuac	Texas	.838	37.4
189	7,088	Hackberry	La.	.850	35.0
190	7,100	Grand Bay	La.	.839	37.2
191	7,113	Aransas Pass	Texas	.817	41.7
192	7,139	Jennings	La.	.847	35.6
193	7,180	Charenton	La.	.845	36.0
194	7,300	Helm	Cal.	.736	60.8
195	7,300	Port Barre	La.	.861	32.8
196	7,352	Cayuga	Texas	.744	58.7
197	7,388	Village	Ark.	.820	41.1
198	7,572	Schuler	Ark.	.859	33.2
199	7,600	Magnolia	Ark.	.821	40.9
200	7,763	Ten Section	Cal.	.836	37.8
201	7,792	Lovell's Lake	Texas	.835	38.0
202	7,805	Embar	Texas	.802	44.9
203	7,838	Stowell-Winnie	Texas	.858	33.4
204	7,860	Dorcheat-Macedonia	Ark.	.703	69.8
205	8,056	Colinga Nose	Cal.	.870	31.1
206	8,060	Santa Fe Springs	Cal.	.854	34.2
207	8,070	Helm	Cal.	.856	33.8
208	8,130	Kettleman North Dome	Cal.	.855	34.0
209	8,200	Barataria	La.	.842	36.6
210	8,201	Atlanta	Ark.	.804	44.5
211	8,305	Big Lake	Texas	.818	41.5
212	8,315	Neale	La.	.833	38.4
213	8,398	Holly Ridge	La.	.840	37.0
214	8,465	Cotton Valley	La.	.718	65.6
215	8,542	Pleasant Valley	Cal.	.877	29.9
216	8,550	Eola	La.	.806	44.1
217	8,572	Cotton Valley	La.	.822	40.6
218	8,585	Bosco	La.	.842	36.6
219	8,600	St. Gabriel	La.	.851	34.8
220	8,618	Quarantine Bay	La.	.846	35.8
221	8,647	Big Lake	Texas	.796	46.3
222	8,650	Coles Levee	Cal.	.850	35.0
223	8,700	Erath	La.	.771	52.0
224	8,730	Pine Prairie	La.	.820	41.1
225	8,750	Baxterville	Miss.	.966	15.0
226	8,780	Moore	Okla.	.788	48.1
227	8,922	Barnhart	Texas	.796	46.3
228	9,010	Delta Farms	La.	.856	33.8
229	9,190	Gibson & Gibson, N.E.	La.	.838	37.4
230	9,558	Lafitte	La.	.842	36.6
231	9,670	Lake Salvador	La.	.846	35.8
232	9,690	Old Ocean	Texas	.844	36.2
233	10,001	Paloma	Cal.	.765	53.5
234	10,063	Bayou Sale	La.	.838	37.4
235	10,076	Paradis	La.	.835	38.0
236	10,288	Brookhaven	Miss.	.895	26.6
237	10,790	T.X.L.	Texas	.821	40.9
238	10,996	Neale	La.	.790	47.6
239	11,240	Rio Bravo	Cal.	.834	38.2
240	11,410	Greeley	Cal.	.837	37.6

it may not properly be classed as oil. The thermal value of all hydrocarbons is dependent upon the carbon content. Condensate and distillate are therefore definitely inferior as fuels. Excessive gas/oil ratios, dangerously high pressures, and the imminence of water encroachment generally render this type of production unprofitable.

To encourage deep exploration many states base production allowables on depth. Schedules are adjusted to estimated drilling costs. Seldom are the actual costs of such operations revealed. Probably very few really deep wells, even if they were capable of maintaining it, may safely be produced at their maximum legal rate. Apparently, whatever oil deposits do exist near the limits of the present drilling range cannot be economically exploited, and our future petroleum requirements must be supplied from other sources.

Shale oil and coal are expected to supplement our diminishing petroleum reserves. Both of these materials may be considered as hydrocarbons containing an excess of carbon. To convert them to standard motor fuels requires the addition of hydrogen in appropriate amounts.

To support the theories here presented the accompanying chart has been prepared from data contained in a Bureau of Mines Bulletin (RI4289). The fields represented by the heavy black vertical lines, to their respective depths, are those reported as producing a minimum of 2500 barrels per day. The tops of pay zones are taken as the producing depths, and those fields for which no specific depths are listed are omitted. The 240 fields represented probably account for the major portion of American oil production. The gravity of the oil produced by each field is represented by a point enclosed in a circle. The chart is based on specific gravities as being more truly representative of fuel values than the API scale. Unfortunately, surface elevations were not given, and the various depths could therefore not be referred to a common datum plane (i.e. sea level). Even so, the downward trend of specific gravities with increasing depth is clearly evident. Particular attention is called to the complete absence of any fields in this category below 12,000 feet.

Significant also is the small number of relatively shallow fields still producing the required 2500 barrels. Stripper production has always been the mainstay of the industry. Heavy crudes not only enter the bore holes more leisurely but resist the influx of water to a much greater extent than do the deeper, lighter oils. It is therefore futile to expect the present deep pools to exhibit the long life characteristics of the old, shallow fields.

The rate at which water enters an oil-saturated zone is dependent upon the tenacity with which the oil clings to the sand grains. The effect of temperature upon the viscosity of petroleum compounds is too well known to justify more than passing consideration. It is well to realize, however, that at the temperatures prevailing in the deeper zones natural water drives alone are capable of almost complete removal of the typical light crudes. Secondary recovery methods are therefore not applicable to most of the deep fields.

In general, the shallower fields contain the heavier crudes. A number of the deepest discoveries produce only condensate or dry gas. Perhaps, at greater depths, only free hydrogen may be encountered.

Decline in Gravity

As may be observed from the chart, the decline in gravities is not a consistent rule. Therein lies the brightest prospect for continuation of the petroleum industry in anything resembling its present form. In any given locality the availability of the component elements has determined the character of the petroleum that was formed. An excess of carbon resulted in heavy crudes while a surplus of hydrogen lowered the gravity proportionately.

To convert shale oil and coal to petroleum in significant quantities will require immense quantities of hydrogen. Installations for generating the gas will rival, in size, some of our largest present refineries. The power required will cut deeply into that contained in the raw materials. These materials may not be transported by our present system of pipe lines. The crude so obtained is inferior in most respects to that remaining in our abandoned shallow oil fields.

Hydrogen must be produced regardless. A practical method for obtaining this element is by electrolysis of water. Plants could be built in the midst of old fields and the gas used for repressuring. Means can certainly be devised for causing the hydrogen to combine with the residual oil. This would have the immediate effect of reducing the viscosity of the crude and moving it toward the producing wells. Pumping would never be required. All gas produced with the oil would be returned to the formation, and finally, when all possible liquid hydrocarbons were removed, the reservoir would be full of dry usable gas.

It is realized that the repressuring of an entire oil field with hydrogen is an extremely ambitious program. But with little or no additional oil to be obtained by still deeper drilling, intermediate depth fields rapidly being depleted and the shallow ones all but abandoned, drastic action and long range planning are imperative. The cost of putting a pilot plant in operation would probably not exceed that of a single 20,000-foot dry hole.

Where cheap electric power is available, hydrogen may be obtained from water at a cost comparable to that now paid for the natural gas being injected into a number of reservoirs. There may be other, more economical sources. It is claimed that gasoline can be manufactured from natural gas more cheaply than it is now produced from crude oil. The process is complicated, but in the final analysis, it amounts to robbing the methane molecule of hydrogen until the residue becomes liquid. The use to which the hydrogen thus obtained is to be put has not been announced. Varying amounts of natural gas are available with practically all produced oil. If the methane molecule can be broken down by electrolysis, twice as much hydrogen can be obtained from it as from water.

Summary

Little or no oil exists in deposits of economic value at depths exceeding three miles. Active water drives, high temperatures, pressures, and characteristically lighter crudes, assure the practical depletion by primary methods of the intermediate depth fields. By far the major portion of all the oil ever discovered still remains underground and less than a mile deep. Low temperatures, pressures, and high viscosities account for 90 percent or more of the original oil content having been left in most of the shallower fields. Unless shale oil and coal are to take over the job of supplying our liquid fuel requirements, this lost oil must be recovered. Artificial water drives and natural gas repressuring are relatively inefficient, expensive, and uncertain as to results.

Under the normal influence of hydrogen percolating from below, petroleum rises to the surface and is dissipated. Under special stratigraphic conditions some of it is concentrated in underground reservoirs. Areas that become elevated lose their major deposits through erosion. The residue is carried to the sea, deposited, and becomes subject to reconversion to oil and gas. If deposition occurs in an area where hydrogen is not being exuded, oil shales result. Each step in the process requires millions of years.

It has been estimated that there are 100 billion barrels of abandoned oil in the known shallow deposits of this country. It will require far less hydrogen to convert liquid hydrocarbons into usable fuels than to obtain them from solid or semi-solid substances. The logical procedure is to add the one essential element, hydrogen, while the oil is still in place.

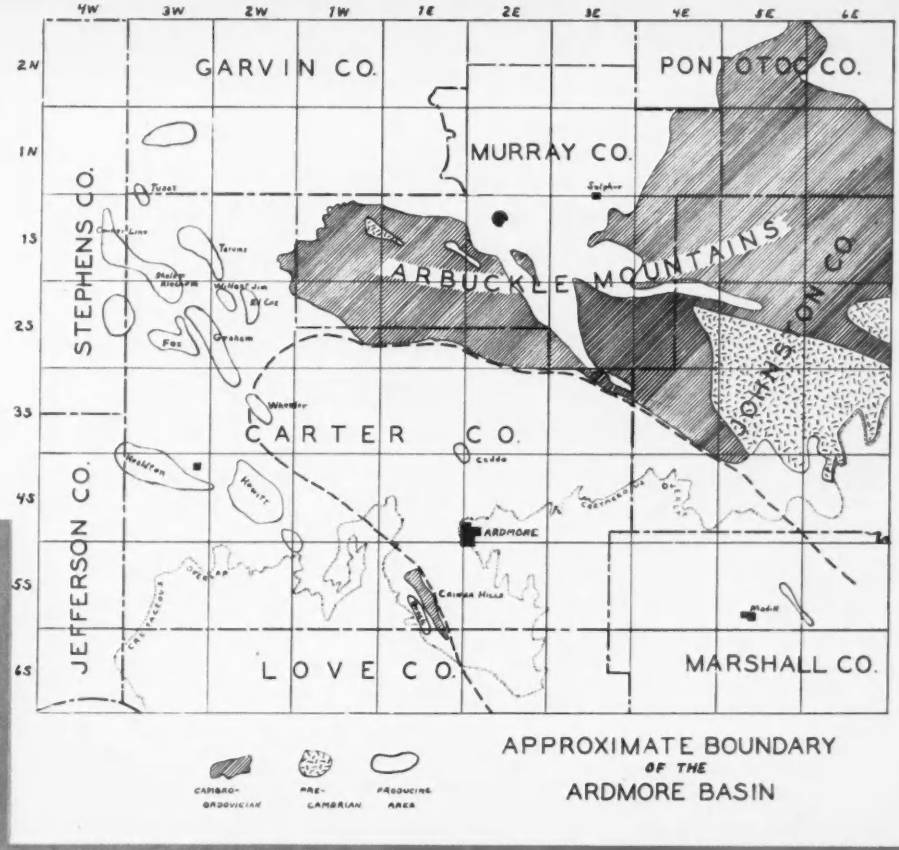

FIGURE 1. While the Anadarko Basin is now conceived to have connection to the Fort Worth Syncline through the structural trough lying between the Arbuckle Mountains and the Criner Hills, the term "Ardmore Basin" is popularly applied to the deeper portion of this structure where Pennsylvanian beds outcrop at the surface.

By EARL T. PETERSON
University of Tulsa

The Ardmore Basin — Geology and Oil Possibilities

THE ARDMORE BASIN of Oklahoma offers possibilities for discovery of important new oil reserves, although relatively deep drilling will be required for its thorough exploration and development. This basin is in the vicinity of Ardmore in Southeastern Carter County and undoubtedly extends southeasterly into Love and Marshall counties.

THE Ardmore Basin as an oil producing area is unique and highly significant in the over-all understanding of the subsurface structure of Oklahoma. Geologically unique, the basin affords an excellent glimpse into problems of structure encountered in the basins to be found in the Rocky Mountain region. From the viewpoint of the oil producer, the area is significant, not only for its past record, but its potentialities as a future reserve.

As it is intimately connected to structures such as Healdton, Sholem Alechem, Hewitt, Graham, and Madill, to name a few, much interest has been shown in the Ardmore basin for the last 25 years. Although production has been obtained in the Carter County sector of the basin for almost a half century, the potentialities of the entire basin are very great. Many reasons exist for the limited production developed to date and these may be ascribed to the economics involved. Pay horizons existing in areas adjacent to the basin lie at relatively shallow depths, well within the normal limits of budgets and equipment and consequently have attracted the oil operator, while these same horizons, in the Ardmore Basin, lie at extreme depths with a complicated folded and faulted structure.

Initial drilling in the Ardmore Basin was undertaken on the Wheeler Dome, Carter County, in 1903, with the first commercial production developed in the same year from shallow sands of Permian age at 900-1000 feet. Even at the present time wells are completed in Permian sands at depths not exceeding 1500 feet in the general area of 35-2w. As already pointed out, economy in drilling so far has governed operations and consequently has restricted exploring the deeper structures which are believed to exist within the basin proper. This fact can be accepted because operators so far have confined most of their drilling to the northern edge or lip of the basin where the deepest production recorded is at approximately 5000 feet in Pennsylvanian sands. Most wells have been drilled to producing horizons ranging from 2500 to 5000 feet.

The Ardmore Basin is in the vicinity of Ardmore in southeastern Carter County. Somewhat elliptical in outline, it undoubtedly extends in a southeastward direction into Love and Marshall counties (Figure 1). At its northwest limits the basin is succeeded by the structural series of anticlines noted as the Hewitt, Healdton, Graham, and Sholem Alechem fields, and their associated smaller structures. To the southeast, the surface expression of the basin loses its identity under a mantle of Cretaceous beds, and cannot, therefore, be defined. It is the opinion of many competent geologists that the basin con-

tinues as a syncline to the northwest into the Anadarko Basin, and southeast toward the Fort Worth Syncline. The northeast boundary is marked by the Western Arbuckle Mountains; the Criner Hills define the southwest limits. Although the Criner Hills are present as a topographic high for a distance of less than ten miles, their control on subsurface structure to the southeast and northwest extends very much farther.

The nature of the Ardmore Basin can best be pictured by comparison to the large Anadarko Basin to the northwest. Where Anadarko beds have a shallow, saucer-like general attitude, the Ardmore sediments have been extremely folded into a series of U-shapes, with several miles of originally flat beds compressed laterally within a narrow trough. If all the sediments were removed, and the granite floor laid bare, the resulting depression would be somewhat spoon-shaped, but with the southeast end much deeper than the northwest end. We may be rather certain of this deepening since, on examining wells in northwestern Marshall County, production is found in Bromide sands at about 3000 feet. However, we cannot say if this deeper portion is a rounded depression or the result of some great fault lying at right angles to the trend of the basin.

Situated as the basin is, whether one considers the Ardmore Basin alone, or its broader geosynclinal aspect, the basin effectively functions as a barrier between the Anadarko Basin and the North Texas area, preventing direct correlation of beds. It is important, not only geologically, but economically, that the correlation be established. In the 25 years that have passed, this relationship has gradually been developed, but much work still remains before someone "comes up with the answer."

Geologically, the Ardmore Basin is extremely important as a laboratory for determining the various earth movements that have taken place during geologic time. Results of study of this area must ultimately aid to show how earth movements bear on migration of oil from source beds, what effect movement has on porosity and permeability, and the oil possibility of structures imposed on or in synclinal areas.

Near the Arbuckles, the strata have been reared up into an almost vertical position by virtue of mountain-making movements. Toward the Criner Hills, these same strata, in reverse order, are again found standing almost vertically. This field relationship, in the early days, was accomplished by study of outcrop, and measurement of dip and strike. As a result the U-shaped succession of folded sediments in the Ardmore Basin is thought to have a thickness of up to 40,000 feet, of which approximately 20,000 feet are Pennsylvanian. By virtue of folding, a crustal shortening of 16 miles is calculated to have taken place (Figure 2).

With the exception of the red beds and Cretaceous sands, Paleozoic rocks including middle Pennsylvanian are extremely folded and faulted by two, and possibly three, major disturbances. Accordingly, steep dips are the rule over the basin. Through overturning of beds, the complex faulting, it is not unusual to pass through the same formation twice. Faults with throws up to 10,000 feet are known. Changes of lithology over a short lateral distance are common, and sands lensing in and out prevent complete agreement among geologists as to the exact age of a given horizon. Add to this confusion a succession of lithologically similar thick shales, and one begins to appreciate the complexity of this area. To simplify the problem of establishing horizons, microfossils are used with good results.

It is perhaps well to look at a brief outline of the conditions of deposition of the Ardmore Basin at this point by way of gaining some understanding of the present structure.

The principal events producing the geologic column illustrated in Figure 3:

A. Pre-Cambrian:

1. Bare mountain-like area with low-lying peaks of granite and schists.

B. Cambrian:

1. Erosion of peaks, and deposition of

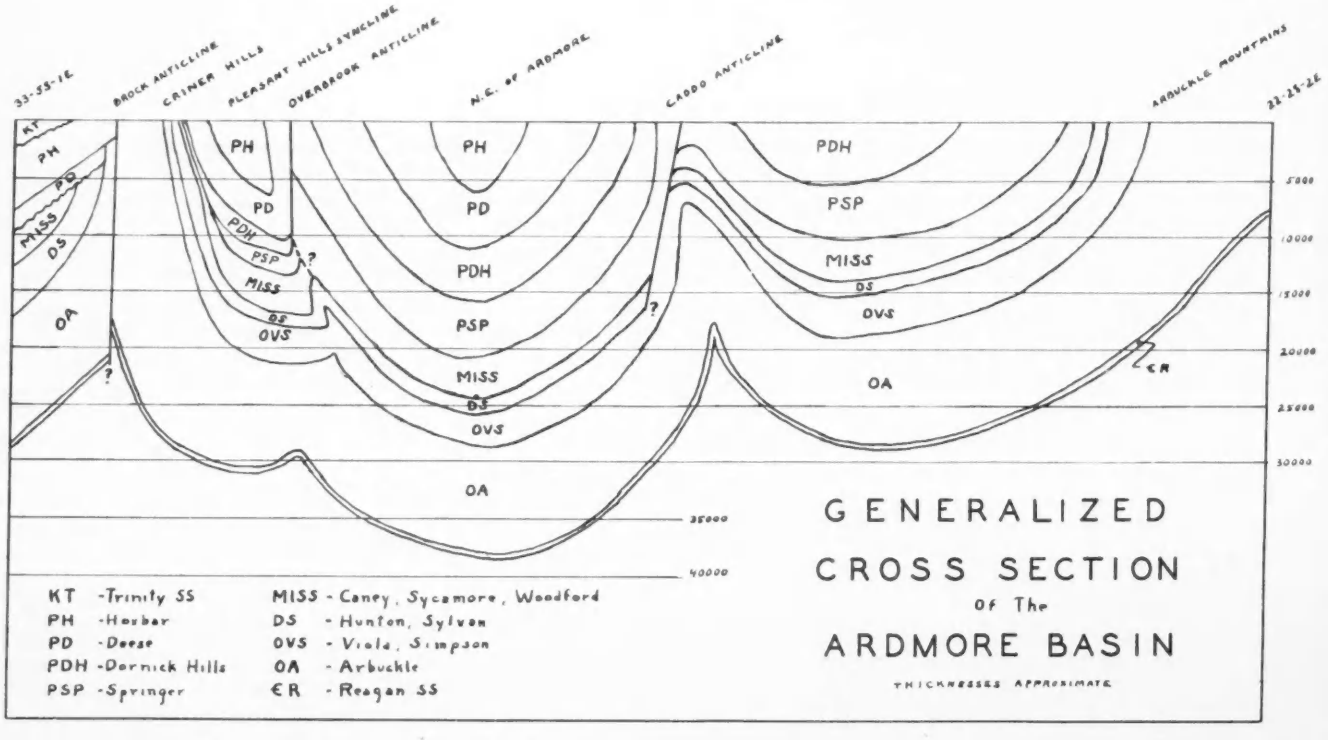

FIGURE 2. Based on surface data, this hypothetical construction shows the general relation of subsurface structure to surface outcrop in a direction transverse to the trend of the Ardmore Basin. Based as it is upon a section originally drawn by C. W. Tomlinson in Bulletin 46, Okla. Geol. Survey, comparison with the original shows that the Arbuckle beds below the Caddo Anticline are now known to lie at least 3000 feet higher than originally assumed. Further comparison, however, indicates Tomlinson's data is essentially sound.

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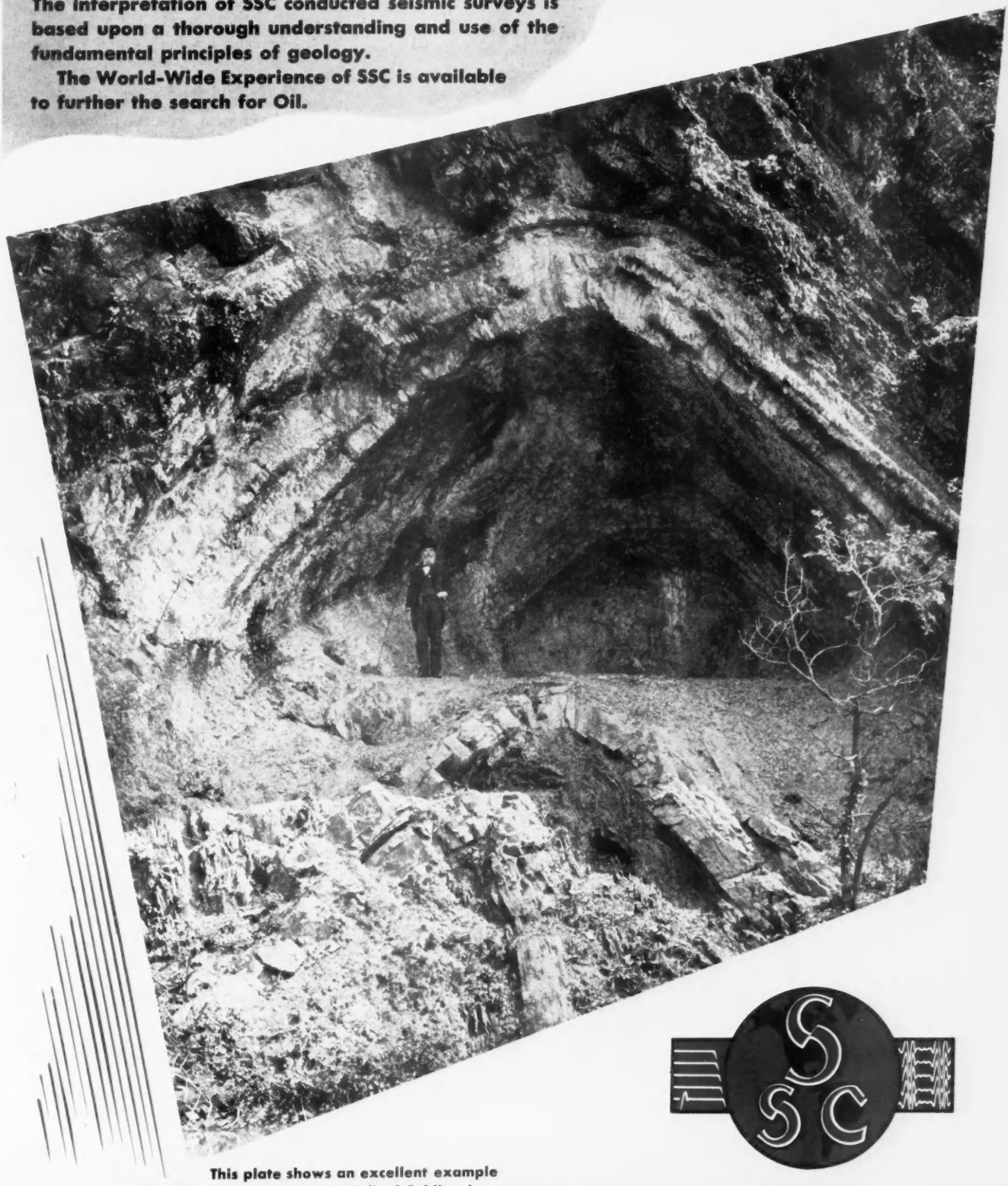

This plate shows an excellent example of Symmetrical Anticlinal Folding in a structure near Hancock, Md.

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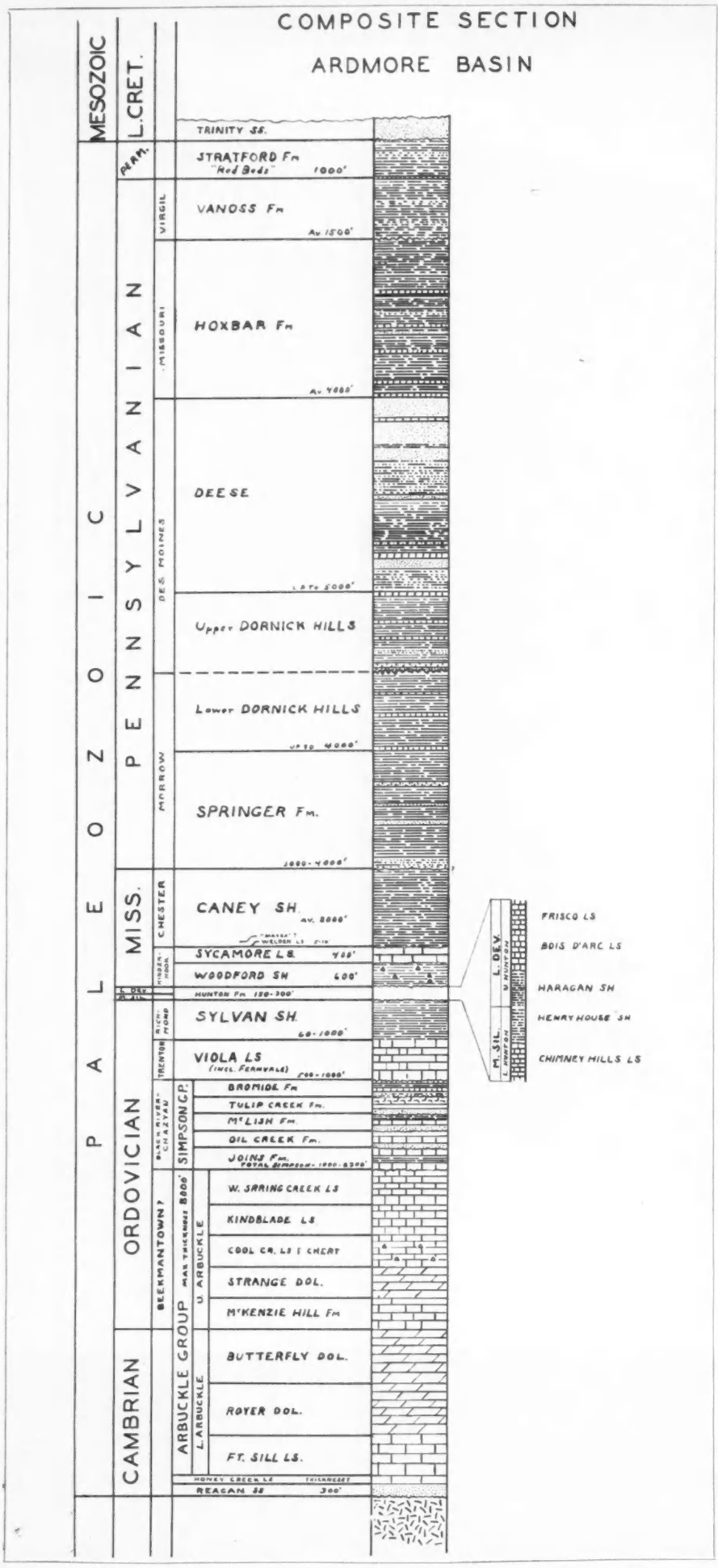

Reagan sandstone on unconformable surface.

2. Advance of seas, and deposition of marine limestones and dolomite of the Lower Arbuckle.

C. Ordovician:

1. Continued subsidence, and uninterrupted deposition of limestone and dolomites of Upper Arbuckle.
2. Fluctuation of marine conditions and erosion with deposition of Simpson group; Joins, Oil Creek, McLish, Tulip Creek, and Bromide.
3. Marine deposition forms Viola limestone.
4. Continued marine deposition forms Fernvale limestone.
5. Low-lying land mass slightly uplifted to form Sylvan shale.

D. Silurian:

1. Marine deposition of Chimney Hill limestone.
2. Slight land uplift forms Henryhouse shale.

E. Devonian:

1. Periods of prolonged surface erosion by retreat and advance of seas from Hunton series of Haragan shale. Bois d'arc limestone, and Frisco limestone. (These units characterized by unconformities, variable thicknesses, and local absence of formations.)

F. Mississippian:

1. Deposition of marine Woodford shale.
2. Added deposition of Sycamore limestone.
3. Uninterrupted deposition of Weldon limestone.
4. Slight uplift of land mass forms Caney shale grading into overlying.

G. Pennsylvanian:

1. Springer formation of great thicknesses of shales and sandstones.
2. Uplift of rather widespread effect: warping of Criner Hills and early uplift of Arbuckle Mountain accompanied by folding and faulting of all early Paleozoic beds (Wichita disturbance).
3. Subsidence, and deposition of sandstones, shales, and limestones to form Dornick Hills, Deese, and Hoxbar formations.
4. Uplift, and Arbuckle Mountains brought into being, accompanied by additional folding and crumpling of beds. Formation of present Overbrook, Madill, Caddo, Graham and Sholem Alechem anticlines (Arbuckle orogeny).
5. Late Pennsylvanian red beds de-

FIGURE 3. The most difficult assumption to make in the Ardmore area is that the stratigraphic sequence is as complete as is shown in the composite section at the left. Beds of Mississippian age, and older, are known to be quite variable in adjacent areas, leaving little doubt that the same situation holds true in the Ardmore Basin.

posited as shallow water deposits on folded beds producing pronounced angular unconformity. Extent of Post-Hoxbar sufficiently strong to be reflected in beds subsequently laid down.

H. Permian:

1. Continental and shallow water deposition of red beds with slight advances and retreats of sea level.

I. Triassic:

1. No record—period of uplift and erosion.

J. Jurassic:

1. No record—period of uplift and erosion.

K. Cretaceous:

1. Trinity sandstone laid down on slightly downwarped surface, overlapping all previous deposition as far north as the Arbuckles, forming the "Cretaceous Overlap."
2. Uplift after early Cretaceous; erosion continuing to present time.

The history of the early Paleozoic is deduced from study of the outcrop in the Arbuckles, but we can only infer that Cambrian beds exist under the Ardmore area. Drilling has not penetrated to them because of depth of burial.

That the stratigraphic picture in the Ardmore Basin is confounding to both geologist and producer is no secret. With dips running from 45 to 90 degrees, it is no small task to attempt to predict at what depth a given sand will appear away from a completed well in any direction. Likewise, interpretation of subsurface data is difficult inasmuch as a given member can be overturned, steep-angled, or even vertical, giving rise to an inordinately thick section. Were it possible to consult the records of the various companies who have participated in development of the Ardmore Basin, the accumulated data even then could not give a complete picture of subsurface conditions for the simple reason that key areas north of the Caddo Anticline, and the region southeast of Ardmore are synclinal in aspect with steep dips and many faults, areas normally shunned by the producer.

Oil Possibilities

The Ardmore Basin proper covers an areal extent of approximately 800 square miles within the boundaries of which, as has already been mentioned, lie vast areas of thick sedimentary sections which have been virtually unexplored. Where development has already taken place the oil prospector has been rewarded by the discovery of many well known and prolific oil fields associated with such general oil-bearing structures as anticlines, stratigraphic traps, unconformity traps and pinchout or lensing sands.

The following illustrates how the various pools in the Ardmore Basin may be classed:

Anticlines: Graham, Hewitt, Sholem Alechem and Bayou.

Unconformity traps: Tatums (in part), Wildcat Jim, Cox, Homer, and Roundup.

Stratigraphic traps: Overbrook, and Healdton (in part).

Lensing sands: Brock.

Compound: Healdton, Brock, Overbrook, and Caddo may be considered compound inasmuch as their basically anticlinal structure is faulted, giving rise to structural traps.

Of these, the obvious anticlinal structures showing surface expression received first attention. Stratigraphic traps are commonly found when dipping strata are faulted. This type occurs on most of the anticlinal structure, and may be present in the synclines. Unconformities normally occur at shallow depths where flat-lying late Pennsylvanian beds lie over the Post-Hoxbar unconformity. Lensing sands occur where strata have been elongated and thinned by folding, or are present due to conditions of deposition. Such conditions are met throughout the Pennsylvanian, in the Viola, and the Simpson.

The three principal anticlines in the

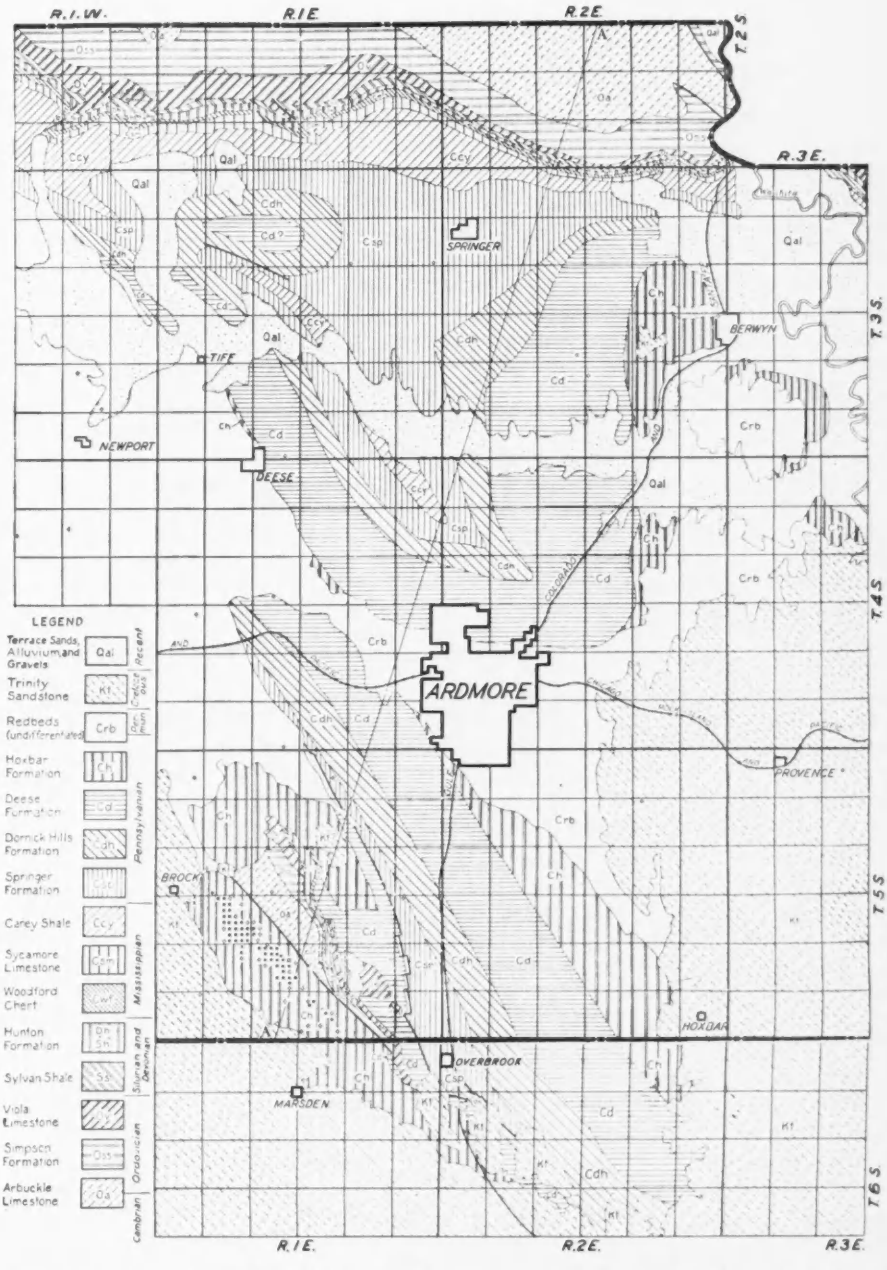

FIGURE 4. The outcrops in the Ardmore Basin reveal a complete Pennsylvanian section. Northwest, these exposures are covered by red beds. Southeast, these same exposures are hidden beneath the so-called Cretaceous overlap. (Map from Bulletin 46, Okla. Geol. Survey.)

Ardmore Basin, the Brock, Overbrook, and Caddo, fird surface expression in surface outcrop. The Brock Anticline (roughly in SE¼ 5s-2e) is the oldest producing structure in the basin (1922) with Pennsylvanian production in Hoxbar and Deese sands.

Overbrook Anticline

The adjacent Overbrook Anticline is an asymmetrical, sharp, elongate, and somewhat overturned fold, faulted along its axis to great depth. Long avoided as a producing area because of the steep dips of the outcrops and the great fault on the axis, it was not until 1942 that the discovery well was drilled. Noble's Joliff 1, NE¼ NW¼ NW¼ 24-5s-1e was completed as a flowing well with production from the Springer at 3210 feet. Due to the Overbrook Fault, production is from stratigraphic traps with the Pennsylvanian wedging out toward the Criner Hills. The western limit of the Springer is at the axis of the anticline, where the fault occurs. No Springer has been found on the west flank.

Drilling appears to be limited to the northeast side of the fault, with production confined to the Dornick Hills and the Springer. Cutting across the fault from the steeply dipping Springer beds only serves to penetrate into Deese or Dornick Hills. Perhaps the most significant fact concerning the Noble discovery is the confirmation of Springer production south of Ardmore.

North of Ardmore, Springer production had been assumed a possibility prior to 1939 because asphaltic material is known from outcrops on the northwest flank of the Caddo Anticline. This possibility was confirmed by completion of Pure-Noble 1, 35-3s-1e. Drilling to 8500 feet, penetration of 570 feet into the Arbuckle showed poor porosity at that depth. The well was plugged back to 4454 feet and completed in the Woodford for 96 barrels of oil. The Springer showed oil, but not in paying quantities.

Pure-Fraser 1, SW¼ NE¼ SW¼ 26-3s-1e, went to 7472 feet, passing 512 feet into the Arbuckle. The well was spudded into vertical Springer beds with little oil show. The well was plugged back to 5414 feet in a Bromide sand, and completed as an 1100-barrel well. Both Pure wells were located on seismic data. The possibility, however, of Springer production is indicated, but deeper production from more favorable structure or sands appears necessary.

Development of production from the Springer is of great interest to the producer. In the past, and to considerable extent in the present, Hoxbar, Deese and Dornick Hills production has been good, but in the ever increasing need to drill deeper, the thick Springer formation holds attention in areas where Ordovician production cannot be obtained because of problem of depth.

In the Springer outcrop, four prominent sandstones are mapped, but in the subsurface, these sands cannot be traced with any success. Each of the prominent outcrop sands is separated by thick gray shales, appearing below ground as containing lenticular sands. Altogether the Springer has a total thickness averaging 3000 feet north of Ardmore. Southward, it is thought that the thickness may increase to 4000 feet, but since it presumably lies as deep as 15,000 feet, the true thickness cannot be established as yet. Too, the theory that this formation becomes nothing but shale to the southeast is purely conjectural.

Where the Springer has been penetrated completely, a very real difficulty is encountered in passing the Pennsylvanian-Mississippian boundary because the lower Springer shale is so similar lithologically to the Caney shale that it is only by minor lithologic characteristics that the two formations can be differentiated.

Simpson production is significant, although none has yet been reported either from the basin proper or adjacent to it. In the Criner Hills, several Simpson sands contain asphaltic material outcrop, indicating that production is a possibility. None has been secured on the Caddo Anticline as yet, but more testing is needed. West of the Overbrook Anticline, in the Lone Grove pool, the Simpson as a producing zone should be tested. Unlike the Caddo pool, where the Simpson has been completely penetrated, no effort in this direction has been made in the Lone Grove pool. The Pennsylvanian section is only about 4500 feet thick in this area, lying in direct contact with the Simpson. Wells are plugged back for Deese production, but as the Simpson is only about 2500 feet thick, a thorough test should be made.

Future Prospects

The future of the Ardmore Basin hinges on deep drilling. With the eyes of the petroleum world focused upon the depths reached in Wyoming by The Superior Oil Company of California (below 20,000 feet), the techniques learned and perfected there will undoubtedly be invaluable at such time as penetration of the Lower Pennsylvanian in the Ardmore Basin becomes a fact. Beyond a doubt, much favorable structure exists at depth. Seismographic highs are known to exist, but their actual nature has not been disclosed as yet.

Whether or not deeper pay horizons exist in the basin is a moot question. The outcrops indicate a definite possibility. There are, however, several points furnishing a pessimistic outlook. We first of all must consider the depths which must be drilled merely to reach the lowest Pennsylvanian beds. Should we successfully drill to these depths, we must still consider the synclinal structure southeast of Ardmore. Lastly, we must recognize the role played by the forces which initially crumpled the basin sediments. Is the section oil-barren because of pressures arising during the disturbance?

E. A. Paschal, writing in the Bulletin of the A.A.P.G. (Vol. 25, No. 1, Jan. 1941, pp 1-22), says, ". . . lack of porosity brought about by excessive compression of the strata may account for the relatively low recovery per acre in the Pennsylvanian sands of the Graham, Fox, and other Carter County oil fields within the geosynclinal area, whereas the Healdton and Hewitt fields on the (Wichita) uplift on the south had relatively high recoveries per acre from Pennsylvanian sands. It is further suggested that the shallow oil and gas found in the red beds on the local structures, such as Wheeler, Graham, Milroy, Velma and Chickasha, within the Anadarko-Ardmore Geosyncline, was caused by this lateral compression which in a sense 'squeezed' the oil and gas out of the Pennsylvanian beds into the overlying strata.

"Oil and gas accumulation in laterally compressed beds is not an uncommon type occurrence as many fields of the world are in geosynclines which have, in general, had an orogenic history similar to these here described."

On the optimistic side, we may point out that production from the western flanks of the basin is an established fact. In addition, thorough geophysical surveys have been made, and indications of structure, though difficult of interpretation, are a definite possibility.

Immediate production in the Ardmore Basin is hardly to be expected; shallower prolific production in adjacent areas makes Ardmore production unnecessary. Rather, let us consider it as a potential reserve when the need to drill deeper is imperative. What can be produced is anyone's guess, but a basin containing sediments having perhaps eight miles of thickness cannot be ignored in any future search for petroleum.

ACKNOWLEDGMENT

The writer wishes to confer credit for all basic data in this article to C. W. Tomlinson, who has published his studies on outcrop geology of the Ardmore Basin in Bulletin 46, Oklahoma Geological Survey. Appreciation is also extended to all those geologists with whom the writer has talked concerning data on stratigraphy which has been made public since Tomlinson's investigations were published.

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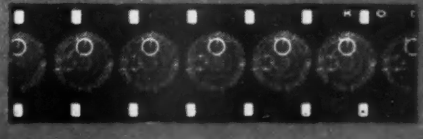

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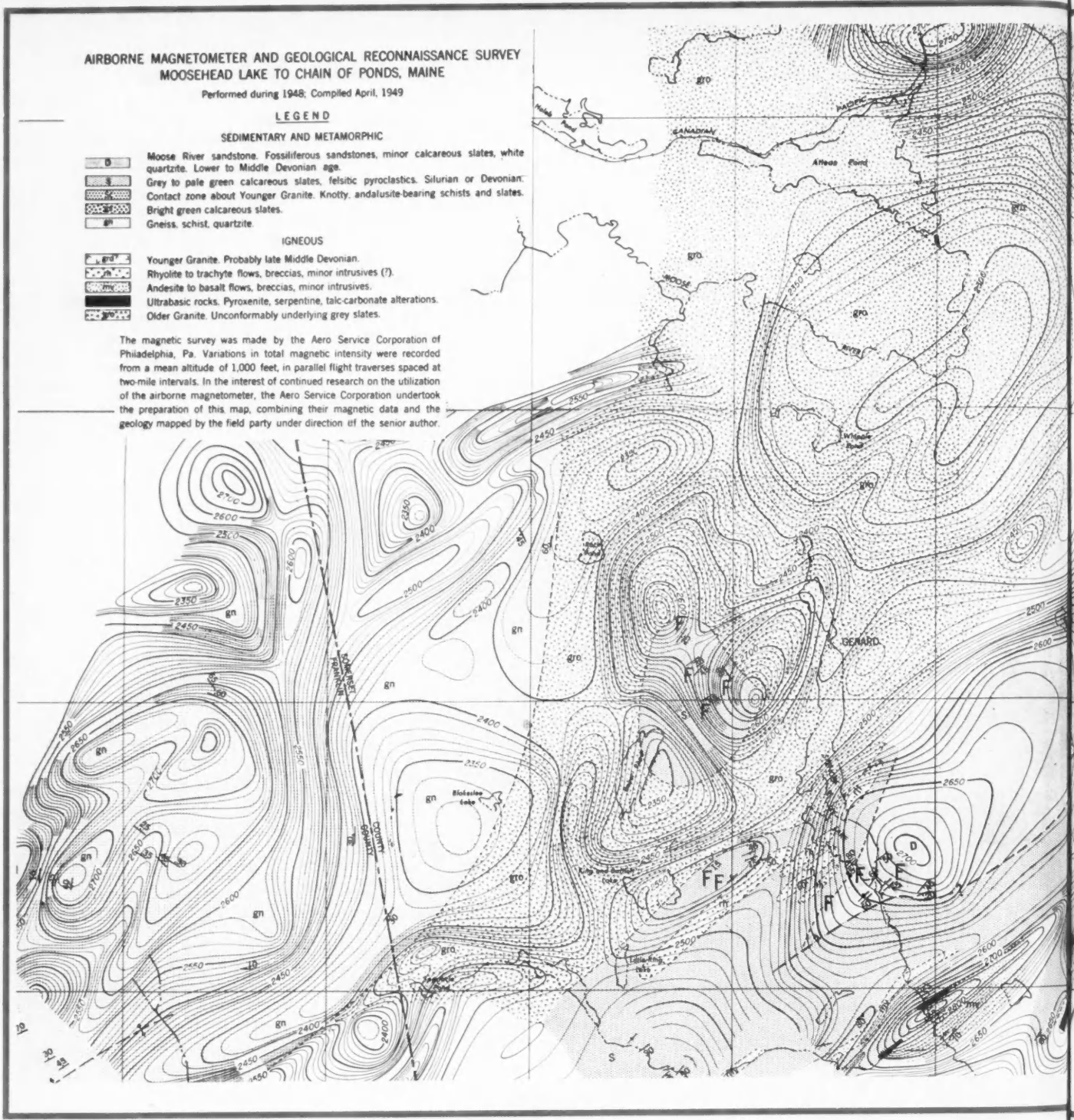
AIRBORNE MAGNETOMETER AND GEOLOGICAL RECONNAISSANCE SURVEY
MOOSEHEAD LAKE TO CHAIN OF PONDS, MAINE
Performed during 1948; Compiled April, 1949
LEGEND
SEDIMENTARY AND METAMORPHIC
Moose River sandstone. Fossiliferous sandstones, minor calcareous slates, white quartzite. Lower to Middle Devonian age.
Grey to pale green calcareous slates, felsitic pyroclastics. Silurian or Devonian.
Contact zone about Younger Granite. Knotty, andalusite-bearing schists and slates.
Bright green calcareous slates.
Gneiss, schist, quartzite.
IGNEOUS
Younger Granite. Probably late Middle Devonian.
Rhyolite to trachyte flows, breccias, minor intrusives (?).
Andesite to basalt flows, breccias, minor intrusives.
Ultrabasic rocks. Pyroxenite, serpentine, talc-carbonate alterations.
Older Granite. Unconformably underlying grey slates.
The magnetic survey was made by the Aero Service Corporation of Philadelphia, Pa. Variations in total magnetic intensity were recorded from a mean altitude of 1,000 feet, in parallel flight traverses spaced at two-mile intervals. In the interest of continued research on the utilization of the airborne magnetometer, the Aero Service Corporation undertook the preparation of this map, combining their magnetic data and the geology mapped by the field party under direction of the senior author.
SOMERSET
FRANKLIN
COUNTY
PISCATAQUIS
COUNTY
Blakeslee Lake
Lily Bay
Moosehead Lake
Indian Pond
Whetstone Pond
Beaver Pond
Pocket Pond
Deadwater
Pond
Holeb
Pond
Canada Falls
Attean Pond
MOOSE
RIVER
GENARD
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gn
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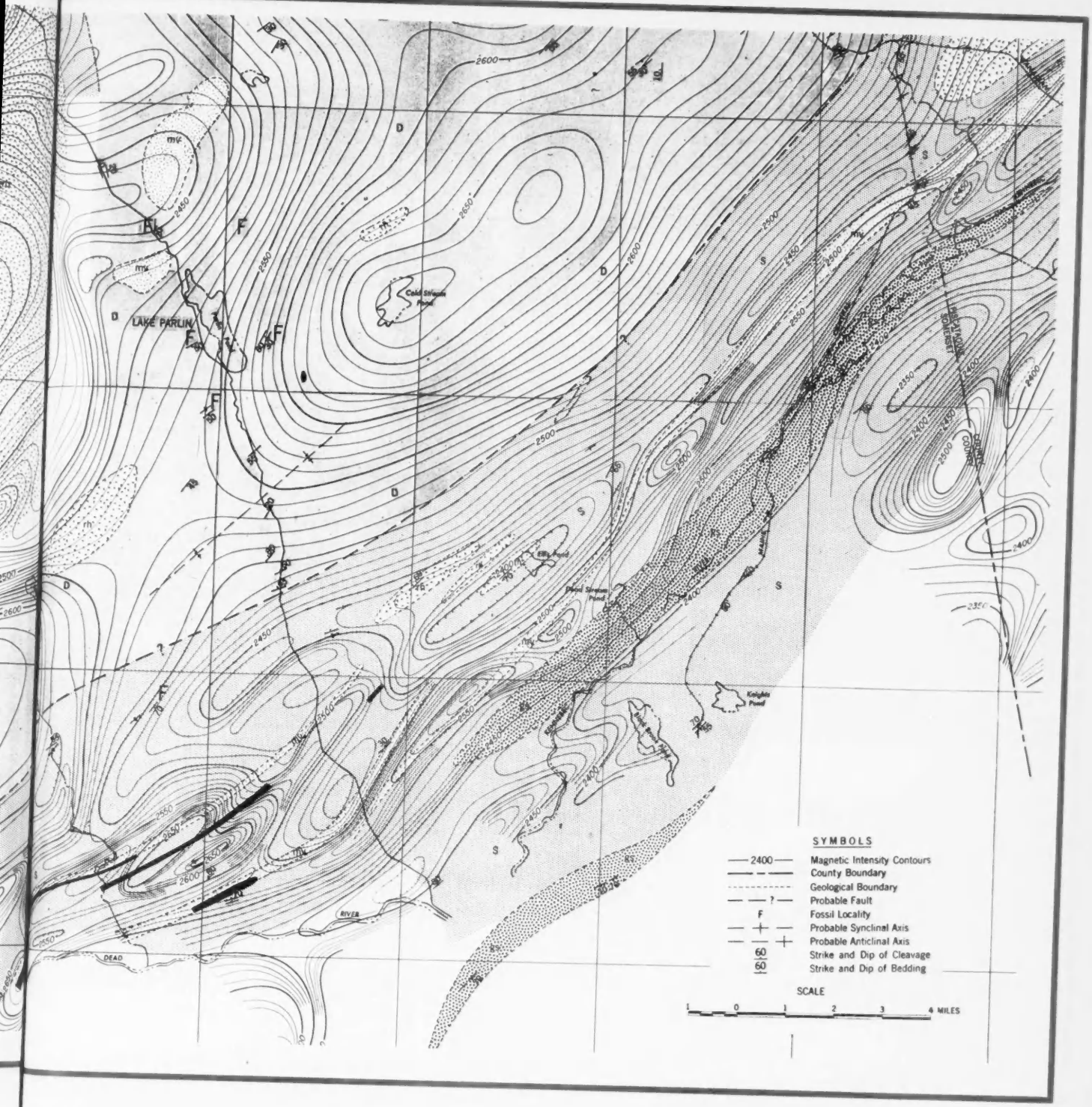
D

Airborne Magnetic Survey

THE utility of aerial magnetics in reconnaissance work has been demonstrated by the correlation of magnetic and geologic data by the airborne magnetometer and field parties during the exploration of a 1200-square-mile area in northwestern Maine.

In the spring of 1948, a contract was let to the Aero Service Corporation for the airborne magnetometer. The general trend of the geologic structures was known to be northeast-southwest, and traverses were planned at right angles to this for best coverage. Roughness of terrain demanded a higher survey altitude than usual, and a mean level of 1000 feet above drainage was decided upon. Mineral surveys often are flown at 500 feet and sometimes as low as 300 feet, where terrain permits. Budget limitations and the expected continuity of the ultramafic bodies led to a decision to use wide spacing—two miles between traverse lines—rather than the quarter-mile traverse common to some types of mineral surveys. Variations in total magnetic intensity as small as two gammas



Checks With Geologic Features

were recorded in a continuous trace. Flying operations were completed during the first two weeks in May. By the first week in June, preliminary magnetic maps were delivered.

Fortunately, this entire area was covered by USGS 15-minute topographic sheets, and these were used as the positional reference for all studies. The magnetic contours were transferred to the quad sheets, and geology maintained on these from notebooks. Thus, the correlation between rock formations and magnetic intensity were in view at all times. The geological map resulting from the field survey and the super-imposed magnetic map are shown in the accompanying illustration.

Early in the field survey it became possible to predict the location of contacts and dikes ahead of the survey by extrapolating on the basis of magnetic figures. As a result, the mapping time was greatly reduced, and the certainty of delineations between outcrops increased.

This is a digest of an article published in Engineering and Mining Journal, August, 1949.

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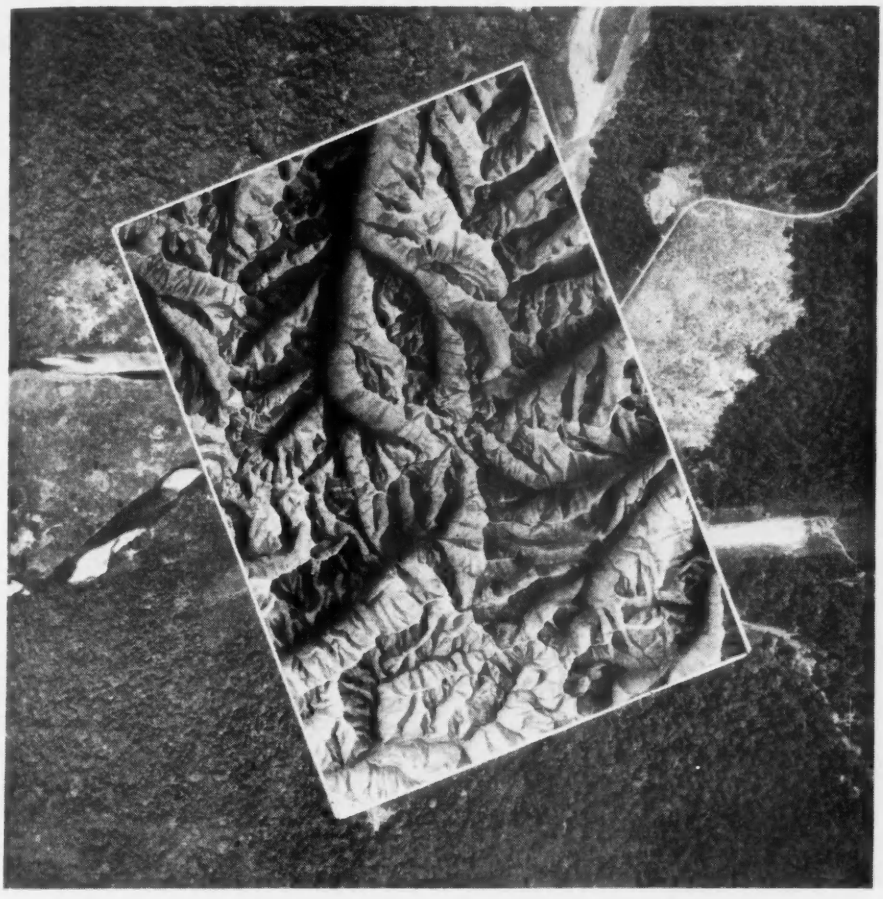

Modern Mapping Methods

By GERALD FITZGERALD
Chief Topographic Engineer
U. S. Geological Survey
Washington, D. C.

WORLD WAR II focused attention on the need for research and development in the field of surveying and mapping, and considerable work is now being done in and out of the government along this line. Each of the three branches of the military services has large organizations engaged in mapping research, and they are also using the services of private industry and universities by virtue of research and development contracts. Civilian mapping agencies also are contributing their full shares to this program in an effort to develop methods that will increase accuracy and decrease costs.

Surveying by electronic methods is definitely on the way and a number of systems have been developed or proposed to accomplish this. Perhaps the best known is shoran, which is closely related to radar. In this system an electromagnetic signal is sent out from an airplane, ship, or other vehicle to each of two known ground stations where it is received and rebroadcast to the originator. By measuring the time of travel of each of the return signals, it is possible to determine accurately the distance from the vehicle to each of the known ground stations. Shoran has been used for long-distance triangulation over water for hydrographic surveying, and for positioning readings in airborne magnetometer surveys. It has also been used as a means of navigation for flying a straight line for mapping photography, and for determining the position in space at the instant each picture is taken.

MUCH PROGRESS has been made, during and following the war, in developing and perfecting the techniques of surveying and mapping, and further improvements are being sought through research and practical application. The advancements are providing increased accuracy and lower costs in surveying and mapping work. This paper is substantially as presented under the auspices of the Distinguished Lecture Committee, AAPG.

By means of electronic systems, a survey may be made without actually traversing the ground between successively located points, except for the establishment of the essential accessory stations. Surveys can be made by day or by night, regardless of weather. The accuracy will, of course, vary with the system employed. Some of these systems are already approaching the point of development where they are technically and economically practicable for many surveying and mapping purposes.

Electronics are also used in pendulum-type, elevation measuring instruments, two of which have been developed recently for use in geophysical prospecting. These instruments—Stanolind Oil and Gas Company's elevation meter and Sun Oil Company's Johnson elevation meter—have been given extensive field tests by the Geological Survey and by the Army's Engineer Research and Development Laboratory. One of these elevation meters has been giving excellent results for several months on a regular operating schedule, with considerable savings in cost over older methods of determining fourth-order elevations. Both instruments can be transported by automobile and use a precise speedometer system for obtaining distances. As the vehicle travels up or down hill, a delicate pendulum indicates the angle of slope while the instrument constantly and automatically multiplies small increments of distance by the sine of each slope angle, and accumulates the products as plus or minus elevation differences from the known starting elevation. Elevations accurate within about one foot may be obtained by running the instrument two or three times over each road where elevations are to be determined. Where less accuracy is satisfactory, a single running may be adequate.

Another electrical instrument, recently developed by the Geological Survey, has been named the Electrical Survey Net Adjuster (ESNA). This instrument accomplishes a least-squares adjustment

JOHN R. SUMAN
Vice President, Standard Oil Company of New Jersey

"none for as long a period as WORLD OIL"

February 1, John R. Suman, Vice President of Standard Oil Company of New Jersey and widely known throughout the producing branch of the oil industry of the world, completed his thirty-third year as a subscriber and reader of WORLD OIL.

At the time he subscribed, he was a young engineer employed by Rio Bravo Oil Company (then owned by the Southern Pacific Railroad) at Houston. He was promoted to the assistant managership of Rio Bravo and for a period was Drilling Superintendent of Roxana Petroleum Company (Shell). He left Roxana to return to Rio Bravo as Manager and left Rio Bravo the second time to become Director of Production of the Humble Oil & Refining Company. He was later made Vice President of Humble Oil & Refining Company and then Vice President of Standard Oil Company of New Jersey, the position he now holds.

He wrote the first book on petroleum engineering ever published. It was composed, in considerable part, of articles written by him for the publication which is now WORLD OIL. He is a recipient of the Service Plaque awarded by the Texas Mid-Continent Oil & Gas Association, was President of the AIMME, recipient of the AIMME Lucas Medal, President of the Oil World Exposition, Chairman of the Houston Wildcat Committee, and is known everywhere for his friendly disposition, his sportsmanship, his sound thinking, and his keen understanding of the oil industry.

He became a subscriber to WORLD OIL when it was known as the "Gulf Coast Oil News," remained a subscriber during the years the publication was known as "The Oil Weekly," and is still a subscriber to it as WORLD OIL. The publication has changed its name, three times, each change meaning an improvement, and John Suman has changed his job four times—each time as a promotion.

Said Mr. Suman recently:

"The oil industry is fortunate in having many good publications. I believe that my name will appear on the subscription lists of most of the worthwhile oil publications but on none for as long a period as WORLD OIL."

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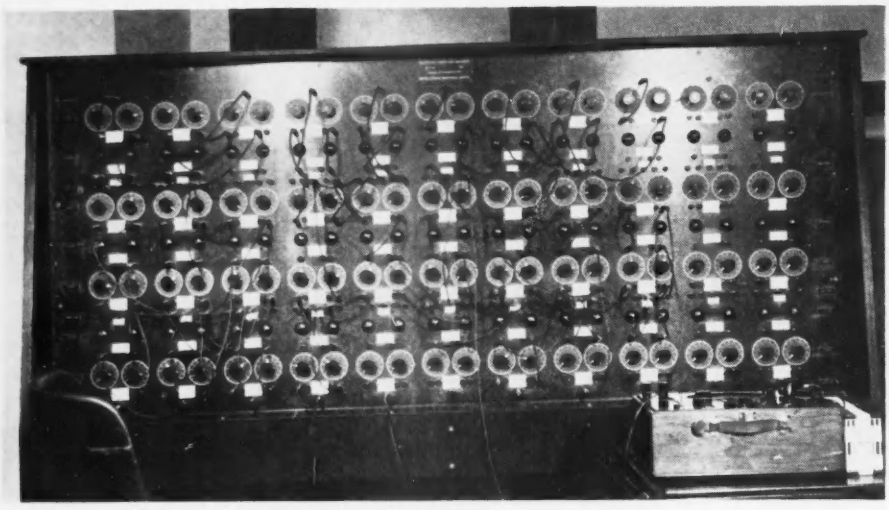
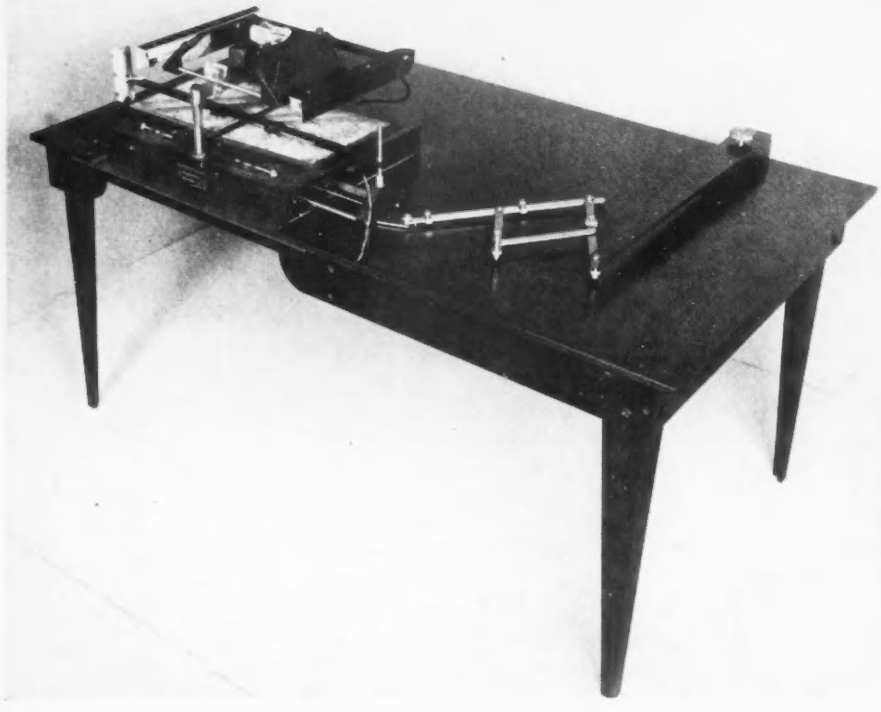
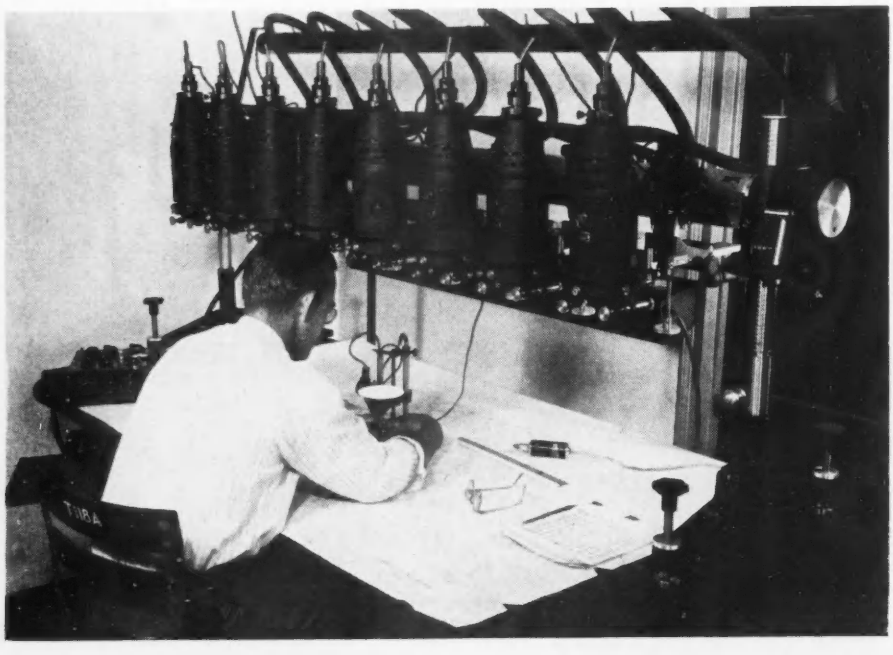






of a survey net, either levels or traverse, by utilizing electric resistance and voltages to simulate survey lines and closures. Its use eliminates laborious mathematical computations and produces satisfactory results. It is understood that this technique was first proposed and used by a petroleum geologist about ten years ago but was discarded because of a change in field procedures.

Many other research and development projects of great interest to topographic engineers and geologists are now under study, but only a few can be mentioned here. Wide-angle camera lenses having no objectionable distortions are badly needed to obtain photography for use in precise stereoscopic plotting instruments. A constant search is likewise being pursued to find or develop more efficient stereoscopic plotters which will permit the mapping of contours at smaller intervals from photography taken at higher altitudes, and thus reduce the number of photographs necessary to cover a given area, with a resultant saving in control surveys.

Two new double-projection-type stereoscopic plotting instruments are under intensive development by the Geological Survey. Both hold promise of greatly improved efficiency and economy over the Multiplex instruments now in use. One, known as the Kelsh plotter is nearly perfected for general use. It is designed to use diapositives at the original negative scale, approximately nine inches square, rather than the small two-inch diapositive of the conventional Multiplex. It has already been used successfully by the Geological Survey and other organizations in the preparation of many types of topographic maps of standard accuracy. It must be considered as still undergoing service trials, however, because it has not yet been used under all extremes of operating conditions. Present indications are that the Kelsh instrument will, by comparison with present Multiplex equipment, yield equivalent contour accuracy

TOP: Electrical Survey-Net Adjuster. Its results are the same that would be obtained by least squares for adjusting out the closure errors in nets of spirit leveling or transit traverse.

●

CENTER: Mahan Stereo Plotter with Pantagraph. Where the accuracy obtainable by more elaborate plotters is not required, this instrument, which uses the vertical aerial photographic prints directly, affords an economical means for the compilation of topographic map detail.

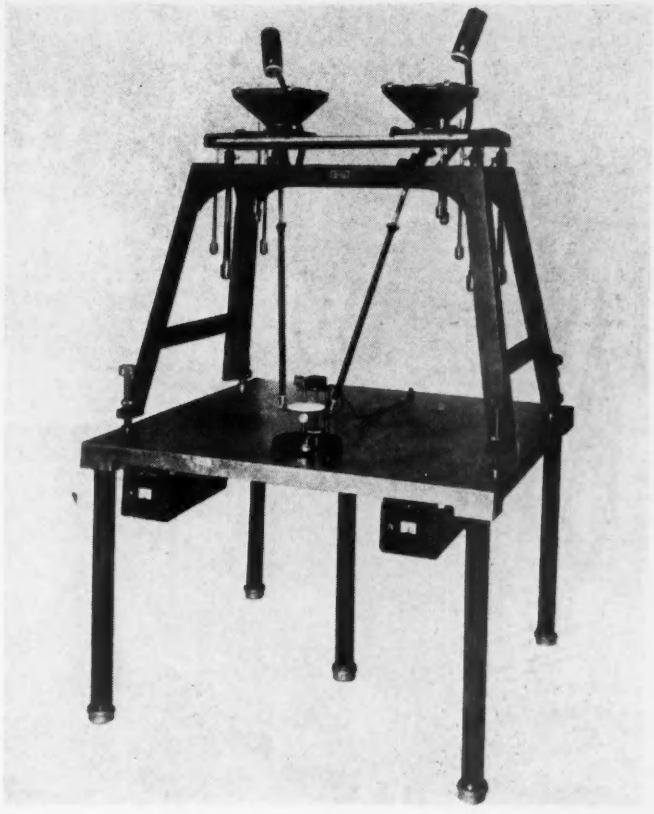
●

BOTTOM: The Multiplex Aeroprojector. In addition to its usefulness in the compilation of topographic map detail from aerial photographs, Multiplex equipment affords a convenient means of bridging or extending control.

from photographs taken at 40 to 50 percent higher altitude. Obviously, some economy should result, because fewer photographs will then be required.

The other development, which although still in the pilot-model stage is showing considerable promise, has been tentatively called Twinplex. Instead of the usual single vertical photograph, a pair of near-vertical photographs are taken at each exposure. The camera has two chambers, each pointed downward at 20 degrees from the vertical. The pair of photographs, later used as a single composite photograph, will cover in excess of 50 percent more area than a single vertical photograph taken under the same conditions. The procedure of plotting maps from these photographs will be similar to the regular Multiplex procedure, except that two projectors, corresponding to the two-camera arrangement, will be mounted together and operated as a single unit. The expected advantages of this design are (1) increased area coverage per flight if the long axis is across the line of flight; or (2) a more accurate determination of ground elevations and contours if the axis is along the line of flight. Either result would reduce the cost of operation for a wide range of conditions. For example, Twinplex cameras probably could be flown at an altitude of 25,000 feet instead of 12,000 feet for the same contour interval, and the net coverage per exposure station would be approximately 20 square miles instead of three.

Research is also being carried on in the field of appropriate graphic presentation of map information. One development within the Geological Survey which is receiving wide interest is the preparation and publication of topographic maps with relief shading. By adding halftone overprints made from carefully prepared airbrush drawings, the topographic, hydrographic, and even cultural features are made to resemble their actual appearance in nature with extraordinary accuracy. The map thus shaded looks like a realistically colored three-dimensional model.



The Kelsh Plotter. Topographic maps can be plotted to a high degree of accuracy, from aerial photographs, by means of this instrument, which utilizes glass diapositive plates of full negative size and is notable for its clarity of image.

Since the beginning of World War II, the Geological Survey has prepared more than 4½ million square miles of shaded-relief mapping. Much of this was specifically to meet AAF flight chart requirements. A limited amount of shaded-relief work is also being done on selected standard survey quadrangle maps.

In recent years many geologists have begun using aerial photographs, either contact prints or enlargements, as bases on which to plot detailed field geology. The problem of accurately transferring this information to the topographic base map is receiving considerable attention. The standard Multiplex projector technique has been tried but is not entirely satisfactory, principally because the geologist's field photographs, marked in colors, must be converted by a camera-copying process to small diapositives which do not show the separate colors. As a result of recent research, it has been demonstrated that several of the less expensive instruments, such as the Survey's Mahan plotter, the Forest Service K.E.K. plotter, and the Kail radial line plotter, are more practical for transferring geology or other information plotted on aerial photographs to the base maps, because these instruments use contact prints directly rather than diapositives. Being of simpler design, they are not only less expensive than the Multiplex projector but can be used satisfactorily by those who have no occasion to become specialists in the operation of more complicated instruments.

In addition to the Geological Survey there are several other organizations in the U. S. engaged in the large scale production of maps and charts. Commercial companies engaged in mapping are increasing in number and many of them are well organized and well equipped. All of these organizations, both commercial and governmental, are interested in producing better maps at less cost. All are engaged in some research and development work toward this objective and, at the present time, there is excellent coordination both in and out of the government service. Under these conditions it is safe to predict that real progress will continue to be made in developing and perfecting surveying and mapping techniques.

About the Author

GERALD FITZGERALD joined the U. S. Geological Survey in 1917, and with brief intermissions to resume studies in engineering, served continuously until 1942 on a wide variety of surveying and mapping assignments in the U. S., the West Indies and Alaska. He became a specialist on reconnaissance mapping and was placed in charge of topographic surveys in Alaska under the Alaskan Branch in 1938. In this capacity he organized and assisted in the original development of "Trimetrogon mapping," a co-operative program between the Geological Survey and the Army Air Forces, to provide world-wide mapping for military operations. In recognition of this work he received the 1944 Photogrammetric Award of the American Society of Photogrammetry.

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Exploration

Highly Successful in January

THE year's exploratory drilling campaign got off to a running start with the completion of 633 tests in January. That total was practically the same as December's 636 wells, but far above activity in January of last year.

A new all-time record in exploratory drilling was set in 1949 when 7464 wells were completed, and an even greater number is the prospect for 1950. In its Review-Forecast Issue, WORLD OIL predicted that 7515 exploratory wells would be drilled this year for a slight increase over the new record reached in 1949. At least the first month's work seems to lend weight to this prediction.

January's 633 tests topped the 515 completed in the same month a year ago by 118 wells or almost 23 percent to give the current program a good fast start toward becoming the most active in history. Although the outlook for 1950 appears to be fewer wells of all types than were drilled last year, the greater role to be played by exploration indicates the industry's determination to prove new reserves despite the production cutbacks of 1949.

Exploration in January not only held its own with the previous month in total wells, but was even more successful. Out of the total, 128 tests found the pay during January for a score of 20.2 percent of all wells, while a month earlier 121 successes amounted to 19.0 percent of the total.

New crude sources found during the month totaled 81, a considerable increase over 72 in December and 74 in January of last year. These new oil pools were composed of 59 newly opened fields and 22 new oil pay horizons in established

Summary of Results of Exploratory Drilling

ITEM	Jan., 1950	Dec., 1949	Jan., 1949	% Diff. Jan., '49-'50
Oil Discoveries	81	72	74	+ 9.5
New Fields	59	57	52	+ 13.5
New Pays	22	15	22	.....
Distillate Discoveries	10	5	10	.....
New Fields	10	3	4	150.0
New Pays		2	6	—100.0
Gas Discoveries	16	14	9	+ 77.8
New Fields	14	11	8	+ 75.0
New Pays	2	3	1	+100.0
Total Discoveries	107	91	93	+ 15.1
Extensions to Fields	21	30	9	+133.3
Oil Fields	19	27	9	+111.1
Distillate Fields	1	1	.....	.....
Gas Fields	1	2	.....	.....
Total Productive Tests	128	121	102	+ 25.9
Dry Holes	505	515	413	+ 22.3
Wildcats	463	494	411	+ 12.7
New Pays	4	3	.....	.....
Outposts	38	18	2	+1800.0
Total Exploratory Tests	633	636	515	+ 22.9
Percent Productive	20.2	19.0	19.8	.....
Percent Dry	79.8	81.0	80.2	.....

Results of Exploratory Drilling, January, 1950, by States

JANUARY, 1950—1949

STATE or DISTRICT	PRODUCTIVE TESTS: New Fields Oil	New Fields Dist.	New Fields Gas	New Pays Oil	New Pays Dist.	New Pays Gas	Extensions Oil	Extensions Dist.	Extensions Gas	Total Productive Jan., 1950	Total Productive Jan., 1949	UNPRODUCTIVE TESTS: Wildcats	New Pays	Outposts	Total Dry Jan., 1950	Total Dry Jan., 1949	Total Exploratory Tests Jan., 1950	Total Exploratory Tests Jan., 1949
Alabama												2			2	1	2	1
Arkansas		1								1	2	7		1	8	3	9	5
California	2			1						3	3	25	1	3	29		32	3
Colorado												4		1	5	2	5	2
Florida																2		2
Georgia												1			1		1	
Illinois	3			1			5			9	5	45			45	34	54	39
Indiana	4									4	5	30			30	38	34	43
Kansas	9									9	8	33			33	31	42	39
Kentucky	1									1	1	3			3	1	4	2
Louisiana	4	3	2	3			2			14	7	20	1		21	15	35	22
North Louisiana	1						1			2	4	14	1		15	8	17	12
South Louisiana	3	3	2	3			1			12	3	6			6	7	18	10
Michigan	5			1						6	3	24			24	31	30	34
Mississippi	2	1								3		7			7	6	10	6
Montana												2			2	4	2	4
Nebraska			1							1		2			2		3	
New Mexico	2			1			1			4	1	5		1	6	3	10	4
Ohio							1			1		1			1	4	2	4
Oklahoma	3			1			1		1	6	7	30			30	39	36	46
Pennsylvania																1		1
South Dakota												1			1		1	
Tennessee											1					2		3
Texas	23	5	11	13		2	9	1		64	54	212	1	30	243	190	307	244
Dist. 1—South Central	1									1	1	18			18	17	19	18
Dist. 2—Middle Gulf	1		1			1				3	7	6			6	11	9	18
Dist. 3—Upper Gulf	1	1		4				1		7	9	11		5	16	26	23	35
Dist. 4—Lower Gulf-S.W.	1	1	4	4		1				11	7	24		3	27	27	38	34
Dist. 5—East Central												7			7	5	7	5
Dist. 6—Northeast	1	1								2	3	10	1	2	13	4	15	7
Dist. 7-B—North Central	7		3				1			11	15	44		5	49	57	60	72
Dist. 7-C—West Central	2	1		1			1			5	2	14		4	18	2	23	4
Dist. 8—West	2			4			3			9	3	31		6	37	9	46	12
Dist. 9—North	6	1	3				4			14	7	47		5	52	32	66	39
Dist. 10—Panhandle	1									1							1	
Utah												2			2	1	2	1
West Virginia											1							1
Wyoming	1			1						2	4	7	1	2	10	5	12	9
Total United States	59	10	14	22		2	19	1	1	128	102	463		38	505	413	633	515

fields. A month before, oil pools had been made up of 57 new fields and 15 new pay strata.

January's distillate discoveries numbered ten, to double the total found in the previous month and to equal those of a year ago. All of the month's were new distillate fields, as no new pay horizons in old fields were opened. December's five were comprised of three new areas and two new sands.

As in the case of crude and distillate discoveries, January also topped its predecessors in the number of gas pools opened. Sixteen pools were located during the period, to shade the 14 belonging to December and the eight a year ago. Again new gas fields totaling 14 dominated the gas discoveries, as did December's 11.

Wells attempting to extend established field production by at least one-half mile are included in the exploratory classification considered here. And it was in this phase of exploration that January failed to measure up to the preceding month. In all, limits of 21 fields were extended, while a month earlier extensions numbered 30.

Oil field extensions topped the list in both months, being 19 in January and 27 in December. Gas and distillate field extensions made up the balance, which was two and three, respectively, for the two months.

Dry Holes

There is one class of wells that the industry is always striving to keep at a minimum and that is, of course, dry holes. There were fewer of these drilled in January than in December, but the totals were close. Month after month exploratory wells that end as failures amount to about 80 percent of the total, and that is pretty much what happened in the months used in this comparison. January's 505 dusters amounted to 79.8 percent, December's 515 accounted for 81.0 percent, and a year ago in January these unproductive tests totaled 80.2 percent. These data show that no matter when the drilling is done, it will require, on the average, about four dry holes for every producer completed.

This dry hole-to-producer ratio becomes even less attractive when only strict wildcats are considered. That is, when new pay tests and outposts are removed from the exploratory totals. There were 546 strict wildcats completed in January, and these were responsible for opening 83 new fields, for a score of 15.2 percent successful. The previous month had been able to record only a 12.6-percent success. In January, 1949, successful wildcats amounted to 13.5 percent of the total. In each of the three periods, wildcatting success bettered the average for the 12-year period, 1937-1948, which was 11.1 percent of all wildcats drilled that opened new producing areas. In view of the fact that the number of to-be-discovered pools have constantly decreased, these present success ratios point to the improvements made in methods of locating new producing areas.

Almost one-half of the U. S. exploratory wells completed in January were drilled in Texas. That state alone accounted for 307 wells, or more than 48 percent of the over-all total. Of these, 64 were producers and they amounted to 20.8 percent of the total drilled in Texas. A year before, only 244 exploratory tests had been completed in the state.

In second place with 54 tests was Illinois, and only nine of these produced. Kansas' 42 wells were good for third place and they also resulted in nine producing wells. Oklahoma with 36 nosed out Louisiana by one well for fourth place in the nation for January. These two states benefited from the month's efforts by six and 14 producers, respectively.

New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in January, 1950

Also Important Extensions to Established Fields

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		ARKANSAS—New Distillate Field						
Columbia		McAlester Fuel Co's Phillips-Schocklee 1-A, C NE SW 33-16s-19w, 5 mi nw Village fld, E. Warnock Springs area.	1-19-50	7403	7394- 7402	Smackover li; Jur	F 25; 0.8 mln; 3/64"	62.6
		CALIFORNIA—New Oil Fields						
Kern		Gilliland Oil Co. & C. O. Davis' Kalloch 1, 330 n 1980 e fr SWC Sect. 11-25s-18e.	12-19-49	2345	1345- 1545	Waggonwheel sh; Olig	P 50; 50 wtr	22.2
Los Angeles		Humble O&R Co's Newhall Land & Farming Co. 1, 650 s&w fr NEC Sect. 23-4n-17w, 1¼ mi se Del Valle fld.	1-15-50	11952	11600-11712		P 152; 1/4"	31.4
		CALIFORNIA—New Oil Pay						
Los Angeles	Placerita	Independent Expl. & Rothschild Oil Co's Phillips 1, 273 s 330 w fr center Sect. 6-3n-15w, ½ mi s of production.	12-29-49	981	800- 981		P 11; 4 wtr	14
		ILLINOIS—New Oil Fields						
Clinton	Carlyle, N.	Conrey's King 1, SE SE NW 23-3n-3w, 2½ mi n Carlyle fld	1-17-50	1151	1147- 1150	Bethel sd; Miss	P 10	
Richland	Calhoun, E.	R. P. Johnson & A. C. Davis' Moore 1, NE NE SE 12-2n-10e, 2 mi w Parkersburg Cons. fld.	1-17-50	3280	3270- 3280	McClosky li; Miss	F 382	
Saline	Long Branch.	W. O. Morgan's Cole 1, (OWWO), NE NE SE 20-7s-6e	1-31-50	3264	3188- 3211	McClosky li; Miss	P 47; 40 wtr	
		ILLINOIS—New Oil Pay						
Bond	Panama	Mayor Drilling Co's Brown 1, SW NW NE 30-7n-3w.	1-10-50	718	701- 718	Golconda li; Miss	P 8	
		ILLINOIS—Oil Field Extensions						
Effingham	Louden	Jones & Simpson's Phillips 1, SE NE NW 19-8n-4e, ½ mi extension	1-24-50	1549	1509- 1519	Cypress sd; Miss	P 50; 24 wtr	
Franklin	Benton, N.	B. D. Jones' W. J. Todd 1, NE NE SW 25-5s-2e, ¾ mi n extension	1-31-50	2466	2456- 2466	Cypress sd; Miss	P 180; 3 wtr	
Wabash	Maud, N Cons.	Sohio Oil Co's Frese 1, SE SW NE 6-2s-13w, ½ mi w extension	1-24-50	2617	2570- 2605	Bethel sd; Miss	P 37; 20 wtr	
Wayne	Zenith	J. W. Everhart's Harrell 1, NE SE SE 35-2n-5e, ¾ mi s extension	1-17-50	2960	2953- 2960	McClosky li; Miss	P 32	
White	Sumpter, S.	M&M Drilling Co's Hubele 1, SW NE NE 3-5s-9e, ½ mi nw extension	1-31-50	2584	2573- 2583	Tar Springs sd; Miss	P 95	
		INDIANA—New Oil Fields						
Daviess	Plainville	National Assoc. Pet. Co's Lockie Meurer 1, SE SW NE 2-4n-7w, 1 mi n Plainville.	1-26-50	747	742- 747	McClosky li; Miss	F 235; 1/2"	
Gibson		Chas. C. Clark's H. M. Montgomery et al 1, SE NW SE 18-3s-11w, Montgomery Twp.	12-22-49	2908	2870- 2880	St. Louis sd; Miss	P 7	
Gibson		Joe Reznik's Lillian Butler 1, NE SW NE 15-4s-10w, 2½ mi e Warrenton pl.	1-31-50	1808	1800- 1808	Jackson sd; Miss	P 25	
Spencer		L. L. Benoists' Anna & Ora Wilson 1, NE NE SE 28-6s-7w, Huff Twp.	12- 8-49	957	947- 954	Waltersburg sd; Miss	P 5	
		KANSAS—New Oil Fields						
Barton	Sunflower	Franco Central & Pickrell Drlg. Co's Klug 1, NE NE SW 8-17s-12w, 2½ mi se Ainsworth, S. pl.	1-12-50	3379	3377- 3379	Arbuckle li; Ord	P 132	
Ellis	Christina	Petroleum Inc.'s Froelich 1, SE SE SW 22-12s-16w, 1 mi nw Emmeram, NE. pl.	1-26-50	3495	3278- 3284	Lansing-K.C. li; Penn	P 195	

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite: li, limestone; sd, sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formation abbreviated thus: Plio, Pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian; U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hour rate), flowing, (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke in inches.

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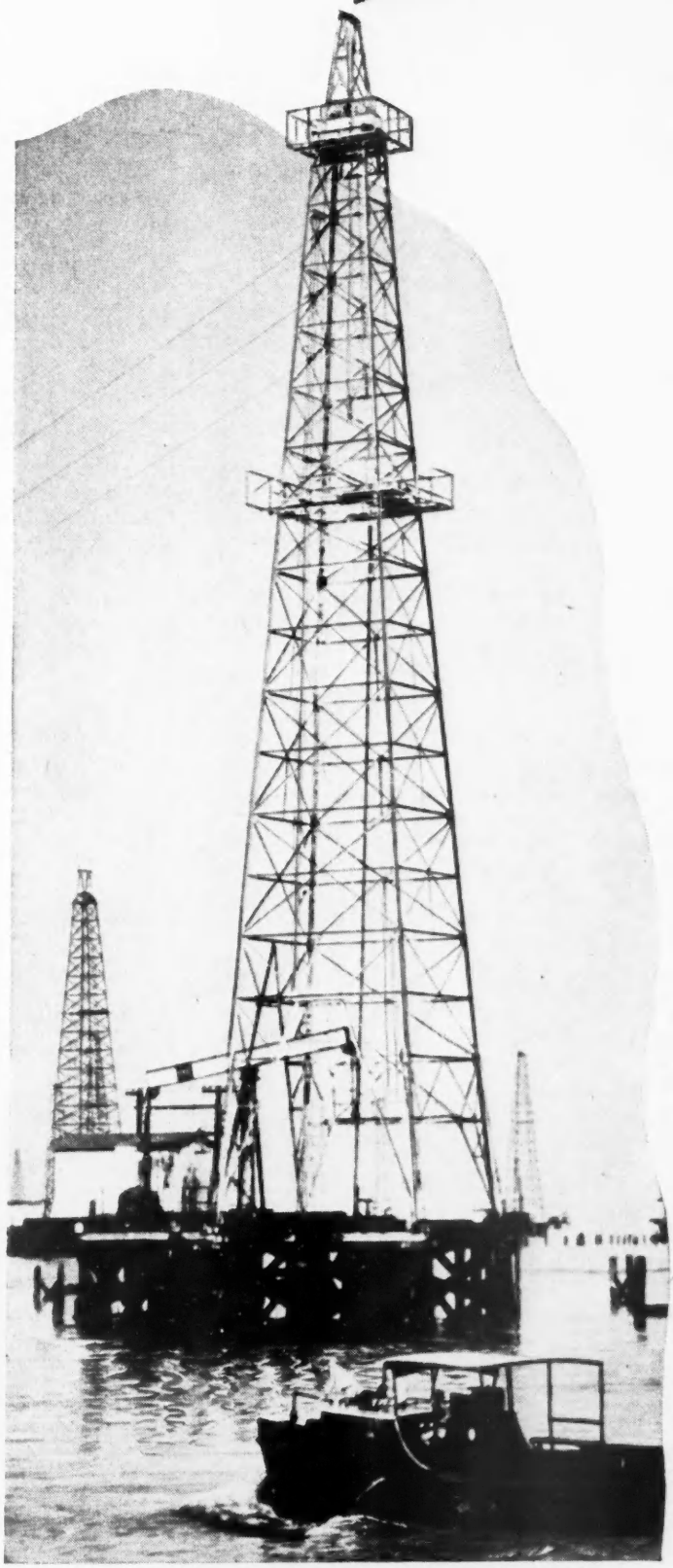

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New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in January, 1950

Also Important Extensions to Established Fields

(CONTINUED)

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
Ellis	Wheatland	Alpine Oil & Rlty Co's Leiker 1, SE SE SW 18-15s-17w, 2½ mi ne Schoinchen pl.	1- 5-50	3585	3569- 3585	Arbuckle li; Ord	P 152	....
Ellis		Skelly Oil Co's Kansas 1-A, SW SW NW 1-14s-19w, 4 mi e Irvin pl	1-20-50	3826	3807- 3826	Arbuckle li; Ord	P 121; 60 wtr	28
Graham	Morel, E	Derby Oil Co. et al's Balthazor 1, NW NW SE 13-9s-21w, ¾ mi e Morel pl.	1-23-50	3733	3728- 3733	Arbuckle li; Ord	Sw 1080	....
Graham	Morel, W	Peel & Hardman-Coppinger & Appleman's Sutor 1, SE SE SE 18-9s-21w, 1 mi w Morel pl.	1-24-50	3840	3827- 3840	Arbuckle li; Ord	Sw 1344	....
Harvey	Jester Creek	Springer & Harper's Leffelman 1, SW NE SE 3-24s-1e, 7 mi ne Goodrich pl.	1-13-50	2692	2348- 2687	Lansing-K.C. li; Penn	P 20; 35 wtr	34
Rocks	Berland, SW	Nadel & Gussman's Sutor 1, NE NE SE 26-10s-20w, 1½ mi sw Berland pl.	1-30-50	3733	3729- 3733	Arbuckle li; Ord	P 505	25.9
Stafford	Pundsack, N.	Petroleum, Inc's Brown 1, SW SE SW 18-21s-13w, 1 mi n Pundsack, pl.	1-31-50	3682	3674- 3682	Arbuckle li; Ord	P 50	....
		KENTUCKY—New Oil Field						
Henderson	Corydon, S	Cherry-Kidd's S. R. Wilson 1, C S½ 8-O-22	1- 5-50	2198	2188- 2192	Cypress sd; Miss	P 97	....
		NORTH LOUISIANA—New Oil Field						
Claiborne	Haynesville, SE.	Ohio Oil Co's Ohio-Gulf—O. L. Martin et al 1, 660 fr el 2020 fr sl 3-22n-7w, 2 mi s Haynesville, E. fld.	1-30-50	11757	9025- 9080	Tucker sd; Jur	F 40; ¼"	45
		NORTH LOUISIANA—Oil Field Extension						
Richland	Big Creek	Stanolind O&G Co's Delta Lbr. Co. Inc. 24, 1652 fr wl 2324 fr sl 10-16n-7e, ¾ mi w extension.	1-12-50	3000	2666- 2690	Tuscaloosa sd; U. Cre	F 269; ¼"	43
		SOUTH LOUISIANA—New Oil Fields						
Acadia		Ralph Lowe's Annie Laughlin Young 1, 330 n&w of SEC Sect. 14-7s-1e, 2 mi. s Bayou Mallet fld.	11-17-49	9122	8904- 8908		F 110; 28 wtr; ⅛"	37.4
Beauregard		Magnolia Pet. Co's Ragley Lbr. Co. 1, 330 fr SEC of NW NE 20-5s-7w, 7 mi e Longville.	1-18-50	10855	8250- 8260		F 12; 2 wtr; 3/32"	45.4
Plaquemines		California Co's North Main Pass Unit 1, SWC Sect. 22-20s-19e, midway btw Grand Bay & Main Pass Blk 69 flds.	1-10-50	9813	9026- 9047	Miocene	F 350; 9/64"	32.9
		SOUTH LOUISIANA—New Oil Pays						
Plaquemines	Lake Hermitage	Gulf Refg. Co's St. Lse 707-Lafourche Basin Levee Dist. 20, Sect. 3-18s-25e	1-18-50	11788	11718-11740		F 160; 9/64"	37.1
Pointe Coupee	Fordoche	The Texas Co's Mrs. R. A. P. Price Unit 2-1, 1966 s 1964 w fr NEC Sect. 28-6s-8e in Unit 2.	1-28-50	9200	8868- 8874		F 136; 59 wtr; ¼"	39.6
Rapides	Big Island	Union Prod. & M. H. Marr's Beaubouef 1, 664 s 665 w of NEC NW Sect. 11-4n-3w.	1- 4-50	6960	5134- 5136		F 211; ¼"	41
		SOUTH LOUISIANA—Oil Field Extension						
Jeff Davis	Welsh	Stanolind O&G Co's Ervine & Bishop 1-A, 330 s&e of NWC of SW SE 21-9s-5w, ne extension.	1- 8-50	6800	6713- 6718	Miocene	F 178; 3/32"	41.2
		SOUTH LOUISIANA—New Distillate Fields						
Acadia		Hassie Hunt Trust's S. W. Robinson et al 1, 2028 w 2543 n fr SEC Sect. 31-8s-1e, 1½ mi w Crowley, N. fld.	1-24-50	11400	10637-10642		F 39; 1 mln; ⅛"	52
Acadia		Hawkins & Jayred's Edmond Young 1, NEC Sect. 31-7s-2w, on w flk of W. Tepetate Dome.	11-30-49	9490	9129- 9141		F 16; 1.5 mln, ⅛"	....
Terrebonne	Eugene Isle-Blk 58	Magnolia Pet. Co's State Lease 673-1-B, in Blk 58	1- 8-50	13800	11205-11208		F 7; 0.4 mln; ¼"	54
		SOUTH LOUISIANA—New Gas Fields						
Cameron		Phillips Pet. Co's Cameron St. Lse 1170-2-A, 1000 fr w 1700 fr s Plk 1-E, Cameron area.	1-25-50	11890	1671- 1674		0.6 mln; ¼"	....
St. Mary		Magnolia Pet. Co's St. Lse 843-Blk 51 1-B, 4350 fr nl 6750 fr el Eugene Isle area Blk 51.	1-23-50	14048	9449- 9451		1.4 mln; ⅛"	....
		MICHIGAN—New Oil Fields						
Allegan		Lowell Bernhardt's Swanty & Peterson Comm. 1, NE SE NE 30-2n-12w, Watson Twp.	1-10-50	1468	1465- 1468	Traverse li; Devo	P 30; 92 wtr	....
Allegan		Ford Oil Co's Kaminski 1, SE SE SE 6-1n-15w, Lee Twp	1- 6-50	1134	1130- 1134	Traverse li; Devo	P 7	....
Allegan		Universal Drilling Co's Berry 1, NE NE NW 21-3n-13w, Monterey Twp	1-20-50	1827	1823- 1827	Traverse li; Devo	P 10	....
Oceana		Mercer Oil Co's Brazee 1, NW SW NW 13-14n-18w, Benona Twp.	1-11-50	2276	1670- 1679	Traverse li; Devo	P 40	....
Saginaw		Graham Wilcox's Shaw 1, SE SE NE 25-10n-6e, Birch Run Twp, 3 mi w Arbela fld.	1-15-50	2522	2460- 2522	Dundee li; Devo	P 25	....
		MICHIGAN—New Oil Pay						
Gladwin	Butman	The Superior Oil Co's Kenyon 1, NE NW SW 12-20n-1w, Butman Twp, ½ mi n production.	1- 7-50	5027	4920- 4930	Richfield sd; Devo.	P 100	....
		MISSISSIPPI—New Oil Fields						
Adams	Natchez	Humble O&R Co's Mrs. C. D. S. McKittrick et a 1-D, Sect 50-7n-3w, ½ mi s Natchez.	1- 9-50	10548	10338-10348	Tuscaloosa sd; U. Cre	F 50	27
Lincoln	Midway	E. F. Neely & Petersen Drlg. Co's Mrs. Geo. Zeigler 1, (OWWO), C NW NW 2-6n-7e, 2½ mi nw Mallalieu fld.	1-16-50	10657	10554-10572	L. Tuscaloosa sd; U. Cre	P 175	38.5
		MISSISSIPPI—New Distillate Field						
Jefferson	Rodney	Danciger O&R Co's Mrs. Kate S. Logan 1, Sect. 18-10n-1w	10- 7-49	9459	9406- 9410	Tuscaloosa sd; U. Cre	F 110; 1.8 mln; 11/64"	58
		NEBRASKA—New Gas Field						
Cheyenne	Huntsman High	Ohio Oil Co's Cruise 1, NW SW SE 7-14n-49w, 7 mi sw Gurley fld.	1-19-50	5195	4742- 4817	3rd Dakota sd; U. Cre	12.5 mln; open	....
		NEW MEXICO—New Oil Fields						
Lea		Gulf Oil Corp's Mrs. Maud Saunders 1, 660 fr sl 1980 fr wl Sect. 34-14s-33e, 13 mi se Caprock fld.	1-15-50	13235	9865- 9882	Pennsylvania li; Penn	F 984; 456 wtr; open	42.7
Lea		Magnolia Pet. Co's Walker-Federal 1, 660 fr s&wl Sect. 8-9s-36e, 4½ mi nw Crossroads.	1-14-50	9729	9715- 9729	Pennsylvania li; Penn	F 501; ¼"	47.1
		NEW MEXICO—New Oil Pay						
Lea	Howse	Stanolind O&G Co's D. E. Howse 1, 660 fr el 1980 fr sl Sect. 11-20s-38e, ½ mi s of production.	1-17-50	4440	4276- 4296	San Andres li; Perm	F 99; ¼"	29
		NEW MEXICO—Oil Field Extension						
Eddy	Empire	Boyd & Plemons Drlg. Co's Gibson 1, 330 fr s&wl Sect. 7-17s-28e, ½ mi n extension.	1- 7-50	498	465- 498	Anhydrite; Perm	P 12	35.3
		OHIO—Oil Field Extension						
Lorain	Ashland-Lorain	H. A. Bachman's Fee 1, Lot 14, Henrietta Twp, 2 mi se of Birmingham	12-23-49	2201	1651- 1686	Newburg sd; Sil	P 7	....
		OKLAHOMA—New Oil Fields						
Lincoln	Happy Hill	Falcon Seaboard et al's Strader 1-A, SE NW NE 8-13n-3e, 3 mi sw Warwick, SE, pl.	1- 5-50	4695	4687- 4692	Bartlesville sd; Penn	F 225; 70 wtr; ¼"	40
Logan		Alpha Pet. Co's Hargrove 1, NE SE NE 1-16n-1w	1-10-50	5090	5072- 5086	Misener sd; Miss	F 205; 7/16"	43
Stephens		J. E. Crosbie's Jesse G. Evans 1, SE SE SW 33-1n-4w, 1 mi n Alma, N. pl.	1-23-50	5130	5029- 5049	Pickens sd; Penn	P 96	34.2
		OKLAHOMA—New Oil Pay						
McClain	Goldsby, SW.	Danciger O&R Co's C. de Cordova 1, (OWDD), NW SE SW 35-8n-3w	1-12-50	10292	9720- 9726	Tulip Creek sd; Ord	F 476; ¼"	40
		OKLAHOMA—Oil Field Extension						
Creek	Slick, S.	Creekmore-Rooney & H&M Dev. Corp's Fisher 1, NW NW SE 31-15n-10e	12-31-49	3424	2210- 2220	Red Fork sd; Penn	P 8	38
		OKLAHOMA—Gas Field Extension						
Pittsburg	McAlester, E	Intex Oil Co's Dupitch 1, SE NE SE 35-6n-15e, ¼ mi e extension	1- 1-50	1795	844- 895	Hartshorne sd; Penn	0.5 mln	....
		TEXAS—District 1 (S. CENTRAL)—New Oil Field						
Guadalupe		F. D. Glass' Frank Zoboroski 1, 330 fr sel 905 fr nel 70-ac Lse, Joseph D. Clements Sur. 14.	1- 3-50	2415	2374- 2415	Taylor sd; U. Cre	F 439; ½"	33.5
		TEXAS—District 2 (MIDDLE GULF)—New Oil Field						
Lavaca		The Texas Co's Cora Russek NCT-1, 3-A, 1100 fr swl 3750 fr nwl Joshua C. Reynolds Sur., 5 mi ne Hope gas fld	1-12-50	10224	5284- 5290	Yegua sd; Eoc	F 136; 9/64"	42.2

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd, sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formation abbreviated thus: Plio, Pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian; U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hour rate), flowing, (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke in inches.

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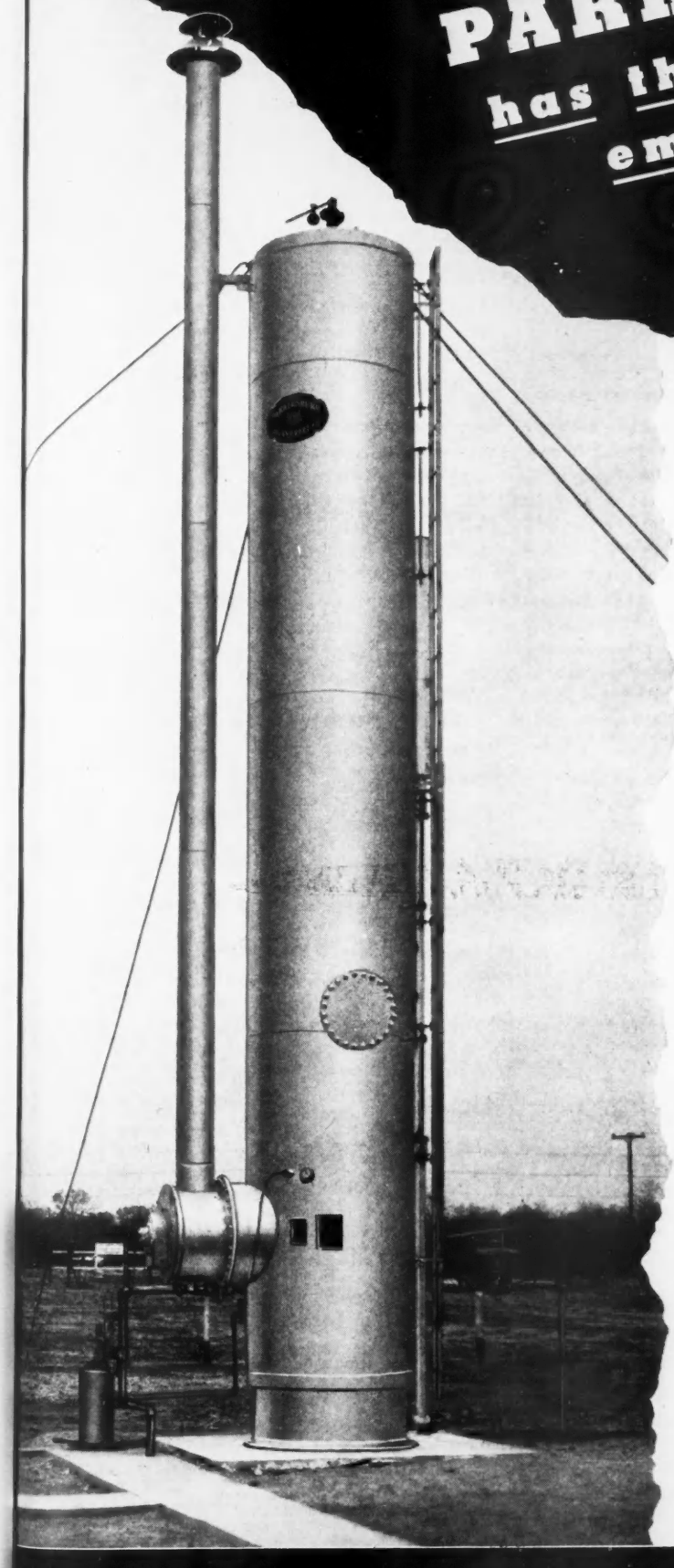

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New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in January, 1950

Also Important Extensions to Established Fields

(CONTINUED)

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		TEXAS—District 2 (MIDDLE GULF)—New Gas Field						
Victoria	Fordtran, W.	Jergins Oil Co's Cora T. Hensley 1, 3600 fr nwl 660 fr w'ly swl IRR Sur. 5, 3 mi w Fordtran fld.	12-18-49	9520	8240- 8244	Wilcox sd; Eoc	No gge	....
		TEXAS—District 2 (MIDDLE GULF)—New Gas Pay						
Victoria	Welder Ranch	Southern Minerals Corp's J. A. McFaddin Est. 1, 100 fr sel 800 fr e'ly nel IRR Sur., 10, 1 mi se production.	11-28-49	5986	5966- 5971	.....	No gge	....
		TEXAS—District 3 (UPPER GULF)—New Oil Field						
Fort Bend	.....	Jack W. Frazier & Humble O&R Co's Will Hartlage 1, 2528 fr sl 466 fr el John Frederick Sur., 1¼ mi s Clodine fld.	1- 9-50	8005	7391- 7393	.....	F 190; $\frac{3}{16}$"	43.5
		TEXAS—District 3 (UPPER GULF)—New Oil Pays						
Brazoria	Liverpool	Humble O&R Co's Frank Johnson 1-B, (OWWO), Angier Hall & Bradley Sur.	1- 5-50	11286	10616-10624	.....	F 304; ¼"	35
Liberty	S. Liberty	Cities Prod. Corp's Nonie O'Brien 8-E, 730 fr nl 300 fr el 98.66-ac Lse, M. G. White Sur.	1-20-50	7145	6566- 3600 6626- 6702	Yegua sd; Eoc Yegua sd; Eoc	F 128; $\frac{1}{16}$" F 257; $\frac{3}{16}$"	36.6 35.1
Matagorda	Tidehaven	G. S. Hinkle's Mrs. Grace P. Heffelfinger 1, 330 fr wl 213 fr sl Lot 2, J. Tilley Sur.	1- 6-50	8830	8569- 8575	.....	F 108; $\frac{3}{32}$"	39.6
Washington	Clay Creek	Alaska Steamship Co. et al's Ida Rosenbaum 1, 5100 fr swl 330 fr nw Nester Clay Sur.	1-29-50	5012	5009- 1050	Wilcox sd; Eoc	F 184; $\frac{5}{32}$"	43.1
		TEXAS—District 3 (UPPER GULF)—New Distillate Field						
Wharton	"Weinheimer"	P. L. D. Well Service Co's E. A. Weinheimer 1, 330 fr nl 7530 fr wl Lyman Conkrite Sur, ⅛ mi nw Gobbler Creek.	12-15-49	5430	5102- 5104	Frio sd; Olig	F 10; 2.2 mln; ¼"	47"
					5217- 5223	.....	F 25; 2 mln; $\frac{1}{8}$"	49"
		TEXAS—District 3 (UPPER GULF)—Distillate Field Extension						
Harris	Durkee	Union Producing Co's Bash 1, 350 fr nl 7660 fr el Geo. E. Green Sur, sw extension.	12-21-49	7720	7700- 7720	Yegua sd; Eoc	F 40; 2.1 mln; $\frac{1}{16}$"	....
		TEXAS—District 4 (LOWER GULF-SW.)—New Oil Field						
Jim Wells	.....	Daubert, Aehning & Quin's Mrs. Lou Ella Wade 1, 2700 fr nel 11000 fr wl Casa Blanca Gr, 1¼ mi n Sandia.	1-17-50	5026	5022- 5024	.....	F 134; $\frac{1}{8}$"	39
		TEXAS—District 4 (LOWER GULF-SW.)—New Oil Pays						
Brooks	Palo Blanco	I. K. Howeth et al's Kathleen Hocker Alexander 2, 330 fr nl 990 fr el 40-ac Lse, Los Meguenes de Palo Blanco Gr.	1- 7-50	4816	4781- 4815	2nd Sejita sd; Olig	F 61; $\frac{3}{8}$"	41
Nueces	Cement	Henshaw Bros. & O. R. Mitchell's H. R. Bryant 1, 330 fr s&wl 88.28-ac Lse, Sect. 45, Geo. H. Paul Sbdn, Driscoll Ranch.	1-18-50	6702	6196- 6201	.....	F 16; $\frac{3}{4}$"	37.8
Nueces	Corpus Christi-Deep	The Chicago Corp's H. E. Butt Grocery Co. 1, 467 fr n&el of 50-ac Lse, Tr. B, Part. McBride Lds, ½ mi sw Corpus Christi fld.	12- 1-49	7008	6914- 6920	Frio sd; Olig	F 163; $\frac{1}{8}$"	51
San Patricio	Sinton, W.	J. M. O'Melveny Prod. Co's Montgomery 4, 330 fr el 440 fr nel Lot 24, John Pollan Sbdn.	1-23-50	3496	2353- 2360	.....	F 215; $\frac{3}{16}$"	21.4
		TEXAS—District 4 (LOWER GULF-SW.)—New Distillate Field						
Nueces	.....	Atlantic Refg. Co's Sam E. Wilson 1, 660 fr nw&swl Wm. Little Sur 594, 1¼ mi e Mustang Island fld.	1- 2-50	8478	6946- 6956	.....	F 19; 3.5 mln; $\frac{3}{16}$"	....
		TEXAS—District 4 (LOWER GULF-SW.)—New Gas Fields						
Brooks	.....	J. R. Frankel's J. L. Cage 1-A, 660 fr n&wl Tex-Mex RR Sur, 10 mi sw Falfurrias.	1-25-50	8005	7804- 7809	.....	34 mln; open	....
Jim Hogg	Edlasater	Gorman & DeLange et al's Mary M. Lasater Est. 2, 2250 fr nl 5100 fr NEC Sur 270, 25 mi sw Hebbronville.	12- 7-49	2572	2032- 2067	Mirando sd; Eoc	16 mln; open	....
Jim Wells	Duboise	Wm. Hamm Jr's Myra L. Duboise 1, Lot 79, J. B. Dibrell Sbdn, J. J. de la Garza Montemayor, Casa Blanca Gr, 4¼ ml s Mathis.	1-23-50	5625	4004- 4014	.....	5.1 mln; open	....
Jim Wells	.....	W. B. Osborn's H. M. Chiles 1, 330 fr n&el 205-ac Lse, part of Shares 4&5 La Vaca Gr, n of Alice fld.	12-17-49	5345	4978- 4996	.....	No gge	....
		TEXAS—District 4 (LOWER GULF-SW.)—New Gas Pay						
Nueces	London Gin	Barnsdall Oil Co's C. N. Cooke 4, 330 fr nl Blk 1, Jones Sbdn of Gallagher Ranch.	1-17-50	5775	4834- 4837	.....	4.4 mln; open	....
		TEXAS—District 6 (NORTHEAST)—New Oil Field						
Wood	.....	Hollandsworth Oil Co's Geo. A. Schenewerk 1, 467 fr nl 3125 fr wl Wm. Wm Fisher Sur, 1¼ mi s Pine Mills fld.	1-25-50	5627	5475- 5490	Woodbine sd; U. Cre	P 110	23
		TEXAS—District 6 (NORTHEAST)—New Distillate Field						
Harrison	.....	La Gloria Corp. & Arkansas Fuel Oil Co's Minnie B. Downs 1, 467 fr el 1130 fr swl Edwin Cater Sur, 3 mi s Waskom fld.	1-18-50	6400	6223- 6327	Travis Peak sd; L. Cre	F No gge; 8.4 mln; open	....
		TEXAS—District 7-C (W. CENTRAL)—New Oil Fields						
Tom Green	.....	Sun Oil Co's M. P. Pulliam 2, 660 fr s&el Sect. 14, Blk 4, H&TC Sur, 4 mi w San Angelo.	1-15-50	5552	5520- 5552	Strawn Reef li; Penn	P 28	37.9
Upton	.....	Humble O&R Co's Ralph Pembrook et al 1, 660 fr nl 2247 fr el Sect. 1, Plk X, C. C. Dewitt Sur, 6 mi n Benedum fld.	1- 8-50	12660	7080- 7100	Sprayberry sd; Perm	P 38	38.6
		TEXAS—District 7-C (W. CENTRAL)—New Oil Pay						
Runnels	Un-named	James E. Kemp's Mrs. M. J. Adams 1, 4350 fr nl 330 fr el Sect. 13, C. D. Skidmore Sur 13, ¼ mi fr production.	1-12-50	4590	4373- 4389	Fry sd; Penn	F 588; $\frac{41}{64}$"	41.9
		TEXAS—District 7-C (W. CENTRAL)—Oil Field Extension						
Runnels	Fort Chadbourne	Delaware Drillers, Inc's B. B. Vick & R. W. Vick, Jr. 1, 330 fr n&el Sect. 452, N. Smithwick Sur, ¾ mi se extension.	1-21-50	5526	5130- 5150	Strawn sd; Penn	P 180	45
		TEXAS—District 7-C (W. CENTRAL)—New Distillate Field						
Crockett	.....	Cities Service Oil Co. et al's Owens 1-C, 410 fr sl 810 fr el Sect. 18, Blk GG, TCRR Sur, 1¼ mi sw Clara Couch Wolfcamp fld.	1- 2-50	7174	5825- 5992	Wolfcamp li; Perm	F 37; 35 mln	....
		TEXAS—District 8 (WEST)—New Oil Fields						
Garza	.....	George Callihan & Harrison's J. C. Dorward 1, 330 fr n&wl SW¼, Sect. 114, Blk 5, H&GN Sur.	1-19-50	2470	2454- 2470	San Andres li; Perm	P 70	36.8
Terry	.....	Tide Water Assoc. Oil Co. et al's J. P. Nystel 1, 660 fr n&wl Sect. 9, Blk 38-C, PSL Sur, 4 mi ne Adair fld.	1-16-50	12094	11475-11542	Fusselman li; Sil	F 1121; ¾"	35.1
		TEXAS—District 8 (WEST)—New Oil Pays						
Andrews	Parker, W.	Humble O&R Co's J. E. Parker Account 8-39, 660 fr s&wl Sect. 1, Blk 54-A PSL Sur.	1-26-50	9144	6940- 7125	Wichita-Albany li; Perm	F 29; 19 wtr; ¼"	34.5
Andrews	Shafter Lake	Sinclair O&G Co's University 12-154, 765 fr nl 555 fr el of NW¼ Sect. 24, Blk 13, Univ. Lands Sur.	1-30-50	11945	8500-10488	Pennsylvania sd; Penn	F 104; open	38.4
Gaines	Flanagan-Clear Fork	Magnolia Pet. Co's H. T. Wolfe 1, 660 fr n&el Sect. 7, Blk 23-A, PSL Sur, 1 mi w production.	1-11-50	7493	6422- 6455	U. Clear Fork li; Perm	P 72	29.6
Midland	Tex-Harvey	Harry B. Lakes' Hugh Dixon 1, SE NW SW Sect. 9, Blk 37, T-3-S, T&P Sur, 1 mi nw production.	1-26-50	7317	7087- 7317	Is. prayberry sd; Perm	F 456; 50 wtr; ¾"	39.8
		TEXAS—District 8 (WEST)—Oil Field Extensions						
Cochran	Levelland	Cities Service Oil Co's F. O. Masten 1-D, 660 fr s&el Lab 3, Lge 133, Armstrong CSL Sur, 1¼ mi sw extension.	1- 5-50	5068	4900- 5020	San Andres li; Perm	F 129; 86 wtr; open	26.5
Ector	Goldsmith-5600'	Stanolind O&G Co's TXL 1, SW NE Sect. 31, Blk 44, T-1-S, T&P Sur, 2 mi se extension.	1-21-50	5756	5688- 5742	U. Clear Fork li; Perm	F 477; ¼"	40
Loving	Mason	Intercoast Pet. Corp's Mrs. M. K. Kyle 1, 1980 fr sl 1000 fr wl SW¼ Sect. 8, Blk 55, T-1, T&P Sur, ¾ mi n extension.	1- 1-50	3955	3887- 3940	Delaware sd; Perm	F 30; open	42
		TEXAS—District 10 (PANHANDLE)—New Oil Field						
Sherman	.....	Phillips Pet. Co's Willelo 1, 2349 fr nl 2530 fr wl Sect. 15, Blk 3-T, T&NO Sur, 2 mi s Hugoton fld.	1-31-50	6462	5844- 5880	Pennsylvania sd; Penn	P 225	40
		WYOMING—New Oil Field						
Natrona	.....	Amerada Pet. Corp's Unit 4, C S½ NW NE 7-36n-77w, 2¼ mi s Sage Spring Creek fld.	1-11-50	7524	7488- 7524	Dakota sd; U. Cre	F 141; ½"	37.1
		WYOMING—New Oil Pay						
Johnson	Sussex, SE.	Continental Oil Co's Unit 10, SE NE SW 23-42n-78w.....	1- 9-50	7610	6375- 6409	Wall Creek sd; U. Cre	F 144	40.5

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd, sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formation abbreviated thus: Plio, Pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian; U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hour rate), flowing, (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke in inches.

Hurricane Damage

To Drilling Platform

By

R. C. FARLEY
Assistant to General Superintendent of Production

and

J. S. LEONARD
Superintendent, Freeport District

The Ohio Oil Company

CONCLUDING THE presentation of the story of hurricane damage to an offshore drilling platform, begun in the February 1 WORLD OIL with two pages of pictures and the article "Wave and Storm Factors in Offshore Structure Damage," this summary by Ohio Oil Company executives is dated December 14, 1949, and entitled "Report of the October 3, 1949, Hurricane and Consequent Damages to the Ohio Oil Company's Offshore Drilling Platform No. 2, State Lease 31794."

I. The Hurricane

At 6:30 p. m., Saturday, October 1, 1949, the Freeport, Texas, office of The Ohio Oil Company was advised by telephone that a tropical storm was forming in the Gulf of Mexico off Merida, Mexico. The communication was relayed from the New Orleans weather bureau. An immediate check with local weather sources failed to provide any further information. However, New Orleans weather bureau advisories Nos. 2 and 3 were obtained during the night from the local Coast Guard Station.

The New Orleans Weather Advisory No. 6, issued at 10 p.m., October 2, showed a change in direction and an increase in forward speed of the storm. The advisory also stated that hurricane warnings were to be hoisted from Corpus Christi to Galveston. Drilling crews were instructed to pull the drill pipe up in the 13⅜-inch casing, set at 3001; lay down the drill pipe standing in the derrick, and otherwise secure all material and equipment against possible hurricane damage, in preparation for evacuation of the platform. Total depth at that time was 6458 feet. The crews finished laying down drill pipe and securing all materials and equipment about 2 a.m. Monday, October 3.

The crew boat was standing by location about 5 a.m. Monday to take off the crew. The last man left the platform at 6:45 a.m.

Figure 1 plots the course of the hurricane according to the weather bureau's advisories. It will be noted that the hurricane pursued a northerly course from the time weather advisory No. 7 was received and that its center passed either directly over or quite close to our drilling structure. It struck Freeport at 11 p.m., Monday, October 3. The main force of the storm was about 50 miles wide. Highest recorded east-southeast wind velocity at Freeport was 92 miles per hour, at 11 p.m. October 3. The lowest barometer reading was 29.

In the late afternoon of October 4 the weather cleared sufficiently for a plane trip to be made from Houston to Freeport and out over the drilling structure. Observation from the air indicated little damage at Freeport or at our Freeport terminal. Extensive damage was visible at the drilling platform, especially to the quarters-house structure, dolphins, fresh-water tanks and the stiff-leg crane. It could be seen that the two houses and some other items had been washed away.

The full extent of the damage was not known until Wednesday, October 5, when a crew boat with Ohio representatives, together with a photographer and others, visited the platform. Upon boarding the platform, it became evident that a complete and accurate inventory would be impossible until sufficient men and equipment could be brought to the platform to sort out the tangled decking and material. However, a preliminary damage report was made at this time.

On October 6 another boarding party, including Ohio personnel from both the Houston and Freeport offices, as well as representatives of J. Ray McDermott & Company, Inc., Brown & Root Construction Company, insurance adjusters for both Kerr-McGee and Ohio, and a photographer engaged by Ohio and the insurers, left Freeport for the platform. After examining the damage a second time, it was agreed to dispatch two drilling crews and several Ohio employes the following day to drain and flush all motors which might contain salt water and to repair or cover any material or equipment that might suffer further damage from the elements. These procedures were carried out with the working personnel setting up improvised sleeping quarters in the mud house while their meals were served from one of the crew boats.

An agreement was negotiated with a marine contracting company from New Orleans, to start the repair and salvage operations as soon as its marine equipment could arrive at Freeport.

By reference to estimates based upon the preliminary damage report, land personnel at Freeport was constructing the necessary piling, fabricating the replacement I-beams, preparing the steel crew houses from our Structure 1 and placing orders for material to replace that lost overboard. When the contracting company's equipment arrived at Freeport October 13 from Louisiana, loading operations preparatory to moving the above-mentioned materials to the platform were begun immediately.

II. The Damage

It was apparent from the position and disarrangement of debris on the platform that the main destructive force of the wind and waves came from an easterly to northeast direction. The axis of the platform and quarter island was oriented approximately N. 50° E., the quarter island being northeast of the drilling platform. The quarter island substructure, comprised of separate jackets—Nos. 1 and 2—above which the galley and bunkhouse were respectively located, gave evidence of the manner in which these buildings were washed into the sea. All of the eight-inch cap beams under the galley house were broken off where they were welded to the piling and were missing, together with the galley. This unit weighed approximately 30 tons. The center pile of three pilings on the northwest end of this No. 1

jacket was bent 90 degrees outwardly, approximately 10 feet below the water line, indicating that the galley house, after breaking loose from the piling, fell down through the jacket to a point not over ten feet below the water line and then was washed out of the jacket into the open sea through the opening where the above-mentioned piling was bent outwardly.

Both of the above buildings were bolted down with three-quarter-inch bolts to the eight- and ten-inch cap beams, which were in turn welded to the 10¾-inch piling. The eight-inch cap beams under the bunkhouse were not lost with the bunkhouse; however, the manner in which they were distorted indicated that the 80-ton bunkhouse was turned approximately 60 degrees off its axis before it tilted and plunged southwesterly from jacket No. 2 into the sea.

The second piling from the northwest end of jacket No. 2 on the side adjacent to the main drilling platform was bent in a northwesterly direction and the protruding ends of two of the cap beams were bent downwardly—indicating that the house slid off of the cap beams in the above-described manner. The 24-inch cap beams on deck section No. 11 at the most easterly corner of the main drilling platform appeared to have been bent upwardly and sheared off.

The 11-inch corner piling at this corner was also bent inwardly and flattened. It is believed that the bunkhouse was washed against the corner of the platform, causing the above damage, immediately after sliding into the sea. The dolphin on the northeast end of the quarter island was pulled out of position and against jacket No. 1 by reason of the bunkhouse falling on the three-quarter-inch cables which secured the dolphin to the nearest piling of the main drilling platform. It was necessary to replace jacket No. 1 because of damage to bracing some 15 feet under the water line, caused, it is believed, by the galley house falling into this bracing. The only equipment remaining on the quarter island was the four-ton stiff-leg derrick and hoist. All three-inch decking around this stiff-leg was torn loose and disarranged but quite a number of loose pieces of this decking were still lying loose on the steel framework of this deck section. Surprisingly, the hoist and diesel engine with its 16-volt storage battery was readily started and the boom of the stiff-leg operated with no apparent ill effects after the storm. Batteries on motors on the main platform were dead following the storm.

Of the four dolphins—two on each side paralleling the main drilling platform — only one remained above the water line. This dolphin was out of position approximately ten feet and leaning against piling of the main platform. Upon inspection of the submerged dolphins by a diver it was found that all three of them had fallen outwardly away from the platform, bending the 8⅝-inch piling in some instances and breaking some of the piling at the welds in other instances as they fell. These dolphins were straightened and piling re-driven where necessary. It is believed a wider base on these dolphin jackets might add to their stability and prevent a recurrence of this in a similar storm.

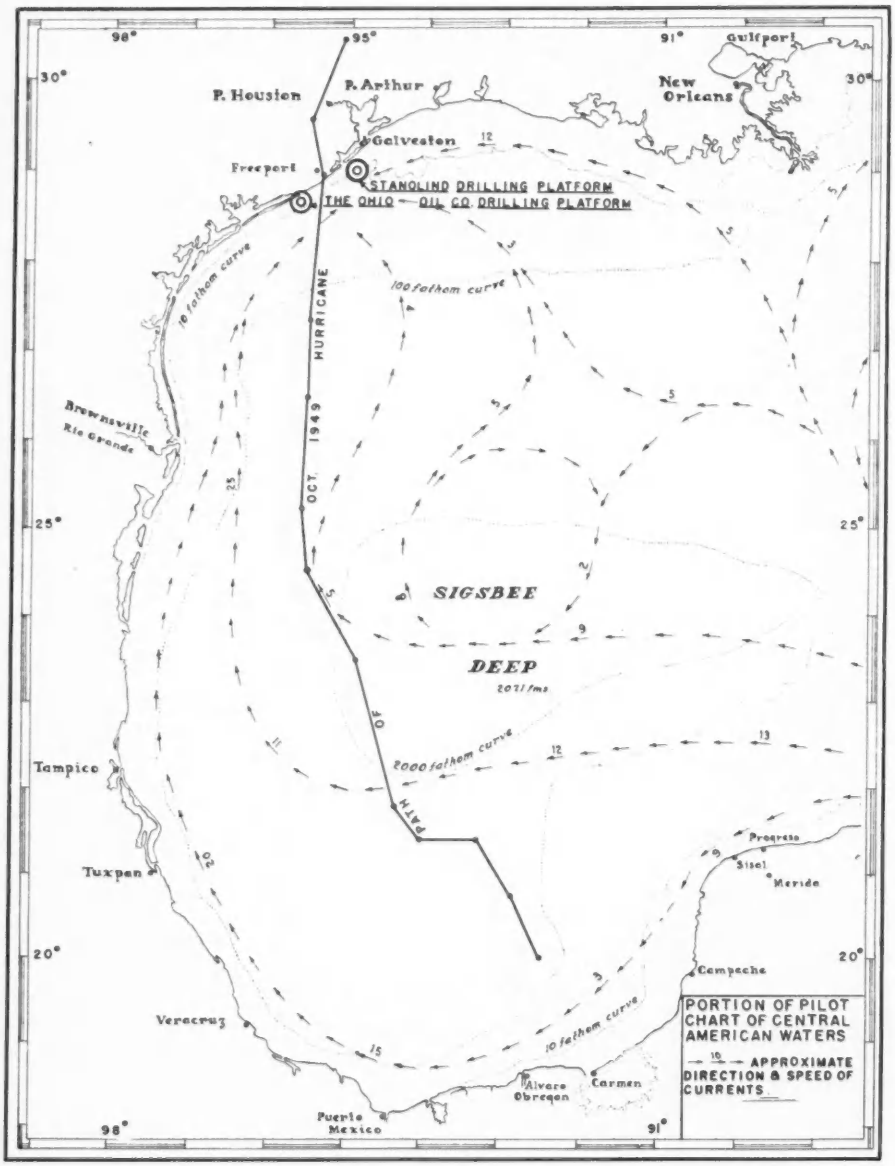

FIGURE 1

Walkways Demolished

All of the walkways and landing platforms constructed out of heavy expanded metal and framed with three-inch angle iron were torn loose from their brackets, which were welded to the jackets. Approximately 90 percent of the above-mentioned walkways was missing. A few pieces of this material were found bent around piling and jacket braces. These pieces were completely crumpled and twisted and draped around piling much like yard-wide cloth might have been.

The entire second deck or mud-house deck, upon which was located the cementing equipment, was leaning approximately three degrees northwest. Aluminum sheathing on the mud-house walls and roof was damaged approximately 40 percent, with the gables at each end of the building appearing to have been blown outwardly as if from an explosion within. The dry drilling mud and chemicals within the building were not extensively damaged from rain or spray as they most surely would have been, had any great amount of rain occurred during the storm.

There was no damage to the 154-foot high by 30-foot base derrick and the 14-foot, 9-inch substructure. However, the engine substructure, upon which the three diesel engines were mounted, was shifted approximately 2½ inches from its original position. One of the slush pumps located under this structure was

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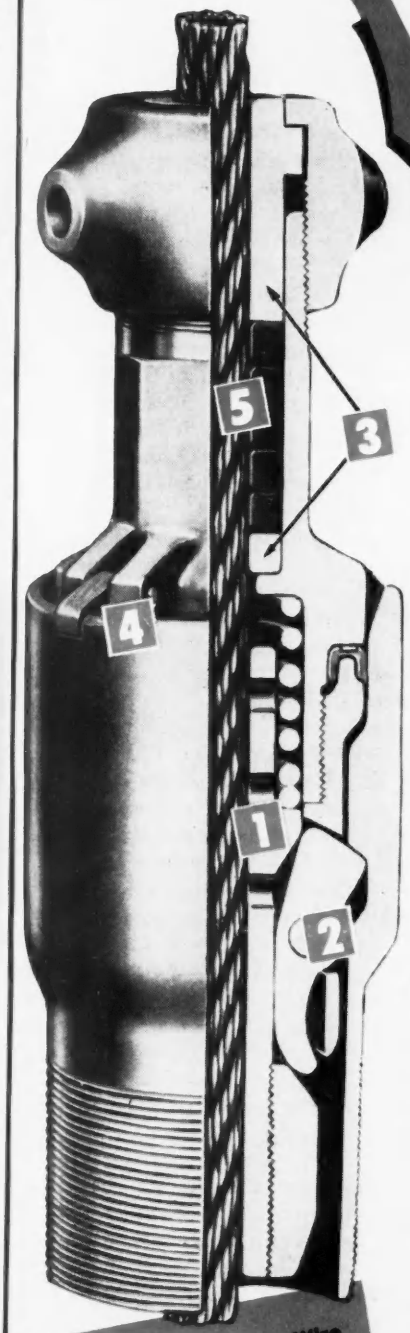

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shifted approximately three feet before its further movement was obstructed by columns of the engine substructure, and it is believed that the impact of the pump as it struck these columns caused the substructure to shift.

The 30-ton stiff-leg derrick on the main platform was shifted approximately 18 inches from its original position, shearing four 1½-inch bolts which secured the pedestal under the mast of this derrick. One of the diagonal legs of the stiff-leg derrick was buckled approximately five feet from the top of the mast. Ten- and four-inch mud lines, fittings and connections were disarranged and broken from the slush pumps to the mud tanks. By reason of these connections being broken off, the mixed mud contained in the three 6 x 8 x 30-foot mud tanks was lost. Two of these tanks were moved out of position approximately ten inches. The slush pump, weighing approximately 41,000 pounds and with a diesel engine weighing approximately 22,300 pounds connected directly thereto, was shifted about six feet from the original position on the main deck under the mud-house deck. The diesel engine was overturned and the radiator broken loose from the engine. The impact of the V-belt sheave of the slush pump against one of the eight-inch columns supporting the mud-house deck possibly could have caused the upper deck to tilt at the angle of three degrees before mentioned, and no doubt caused the shattering of one 11-inch piling below the level of the main deck where it was welded onto the jacket. This was the only internal piling damaged on the main platform.

There were only two 11-inch pilings broken completely loose on the main platform, the corner piling mentioned above in jacket No. 11 and the third piling from the corner in jacket No. 5. It is believed that the bunkhouse being thrown against the end of the main platform caused all of the damage to these two pilings. However, about 15 pilings were cracked loose where they were welded to the cap beams on the outer perimeter of the main drilling platform. Most of the piling broken in this manner was near the southeast side of the platform. The one exception to this being the pile on jacket No. 5, which was shattered and out of line about one inch just above the point where the jacket was orange-peeled to the piling. This break was no doubt due to the impact of the slush pump against a column resting on this piling.

Tanks Lost

Located on the main-deck level beyond the mud house were three 295-barrel steel welded tanks and two low 250-barrel bolted API storage tanks lined up across the width of the platform. Two of the 295-barrel welded tanks were approximately half full of diesel fuel and the third was completely full of water. The center tank of these three was lost overboard and the other two moved a few feet from their original position. The two bolted tanks were collapsed and were 100 percent losses—one being moved from its original position to a point in under the mud-house deck. One of these bolted tanks contained five feet of water and the other was full of water prior to the storm. However, the fittings and connections were broken off near the bottoms of the tanks and they were empty after the storm.

At the pipe-racking end of the main platform several joints of 9⅝-inch casing were shifted laterally five or six feet, and one of the six horizontal water storage tanks was shifted eight inches laterally. The pipe rack beams were bent in the southwesterly direction that the water tank was shifted ten feet back from the edge of the platform.

Three-inch wood decking between the tanks was broken loose from the nailing strips and was missing. Approximately 80 percent of the three-inch wood decking and 3x8-inch nailing strips which were bolted to the deck beams with three-eighths-inch bolts were torn loose. However, a considerable portion of this lumber remained on the platform. The 60-penny nails in the three-inch wood decking and the holes made by the three-eighths-inch bolts in the nailing strips which were pulled loose by the force of the storm indicated that the force applied to disarrange this decking was vertical. It was observed that most of the nails and by far the greater number of the three-eighths-inch bolts were not bent.

TABLE 1
Wave Characteristics Near Galveston

(1) Mean depth of water, feet	250	100	60	50	40	30	20
(2) Wave height, feet	35	32	32	32	32*	24*	15*
(3) Crest elevation above mean surface level, feet	17	16	16	16	24	18	12
(4) Maximum storm tides, feet	0	0	0	2	5	8	12
(5) Maximum astronomic tides, feet above mean sea level	1	1	1	1	1	1	1
(6) Depth at calm which under worst storm conditions would result in depths in line (1)	....	99	59	47	34	21	7
(7) Elevation above mean water level during calm, which crests reach under worst storm conditions	18	17	17	19	30	27	25
(8) $\frac{P}{C_D}$ at crest in lbs./ft.²	144	169	196	225	2300*	1750*	1100*

* Waves have broken.

III. General Discussion

The drilling platform No. 2 and the adjacent quarters platform erected for drilling The Ohio Oil Company's second test in the Gulf of Mexico was designed by the firm of J. Ray McDermott & Company, Inc., of Harvey, La. Structure No. 2, with which this report deals, is located (Figure 2) in North Latitude 28° 38′ 20″, West Longitude 95° 40′ 21″, on State Lease 31794, Gulf of Mexico, Tract 403, being also approximately six miles off the Matagorda County, Texas, coast near Brown Cedar Cut and 27 miles southwest along the shore from Freeport.

The technical basis for designing both of the above-mentioned structures was derived from a paper prepared by Dr. Walter H. Munk, Institute of Geophysics and Scripps Institute of Oceanography, University of California, at the request of J. Ray McDermott & Company, Inc. Dr. Munk is considered one of the foremost authorities in the U. S. on wave action. Much of the work in his paper represents the results of research carried out for the Hydrographic Office, the Offices of Naval Research, and the Bureau of Ships of the Navy Department, under contract with the University of California.

Designers of offshore drilling platforms generally agree that there is an urgent need for additional data on wave forces as they affect structures. Some of the data presently in use are based on studies made years prior to the advent of the drilling platform. Many competent engineers doubt the adequacy of the information at hand for use in determining wave forces to the degree of accuracy required for designing such structures. Present offshore development costs are near the economic limit, hence the need for reliable data as an aid to cost reduction by avoiding overdesign is critical.

It is believed that practically all of the major damage sustained by our drilling platform was caused by wave action and that only minor damage was caused by wind. To sustain this belief, there was ample evidence in the form of debris left on the platform after the storm had passed. It is believed that this minor wind damage would have been the only significant damage if the main decks of our drilling and quarters platforms had been only a few feet higher.

At the June 16, 1949, meeting of the Offshore Operators' Committee at Houston, engineers and others interested in offshore operations, representing 12 oil companies, discussed wave action at length. The discussion indicated that

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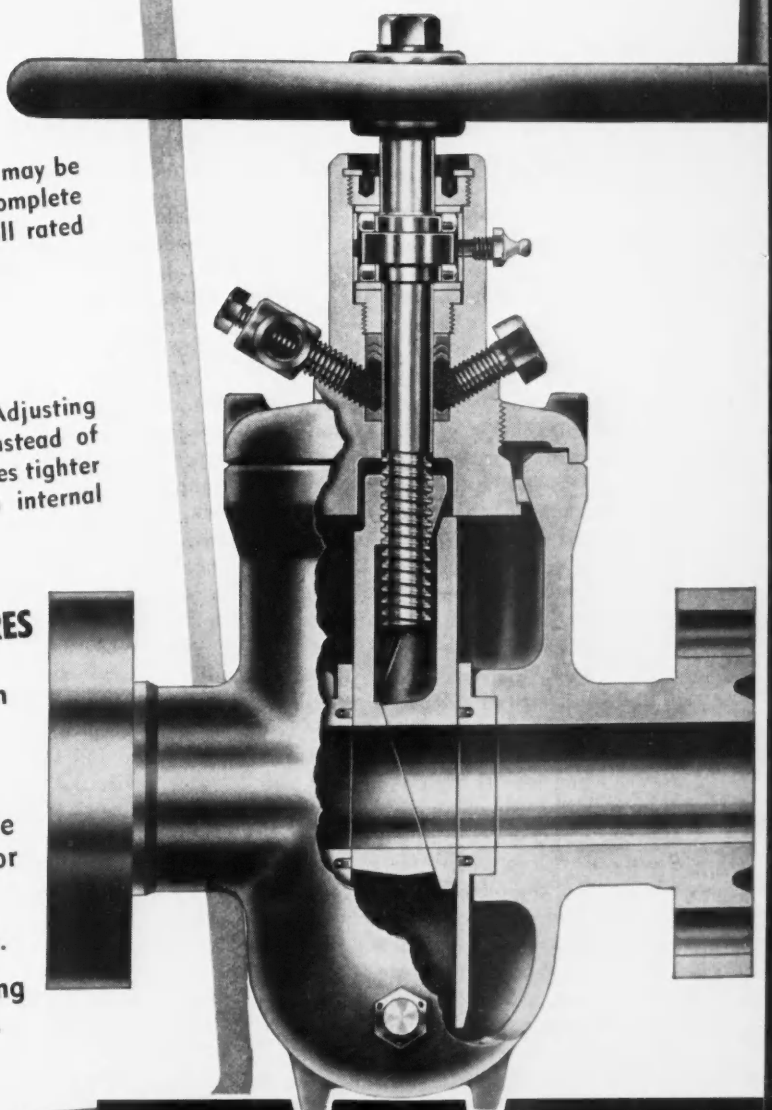

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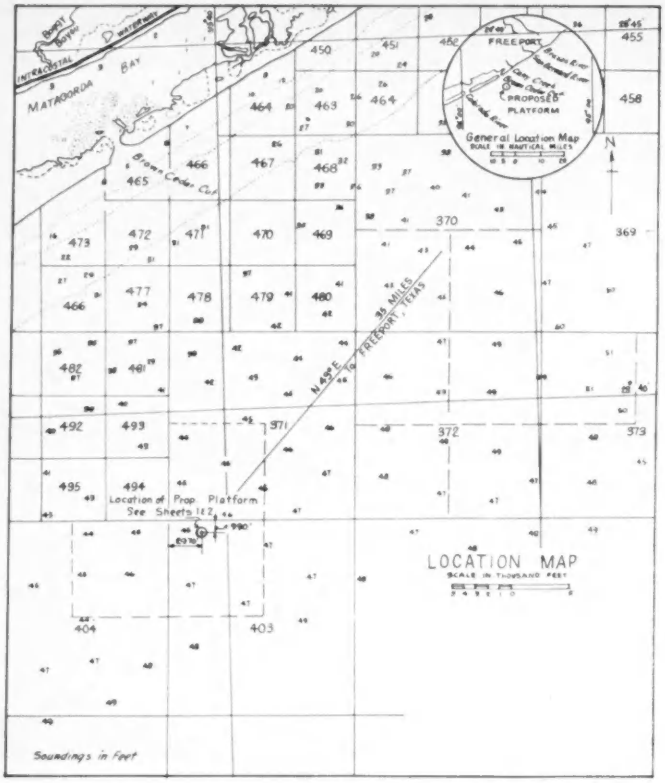


FIGURE 2

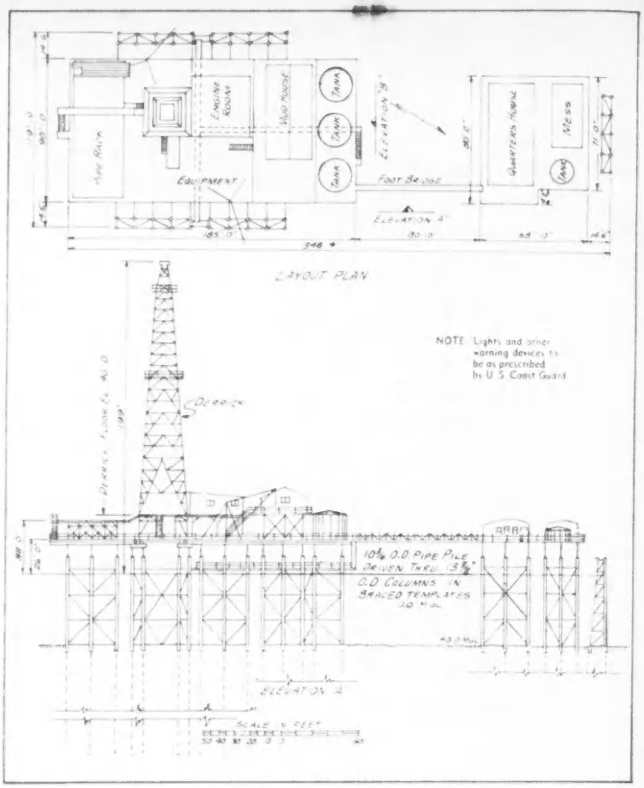


FIGURE 3

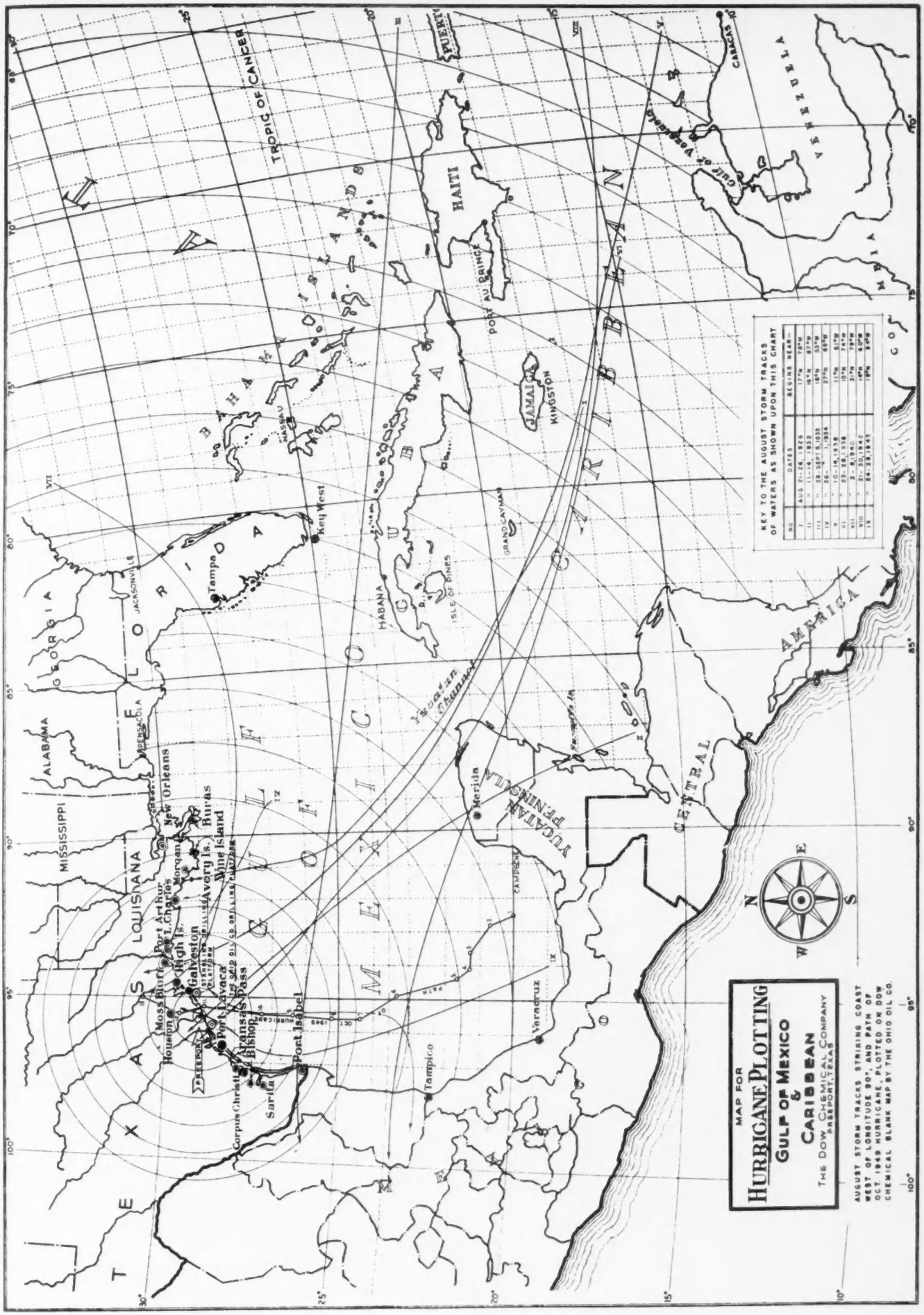
most operators thought that a further planned study of the problem, blueprinted by some qualified research organization, would be beneficial. Apprehension was expressed as to whether the platforms presently in use might not be over-designed or under-designed for their intended use. Representatives of all companies agreed that additional data on wind forces, to be obtained either by model studies or by actual measurements in the field, would aid tremendously in reaching the goal of designing a less expensive and safer offshore platform, soundly adapted to fit into the pattern of economic limitations and hazards of the sea. It was also suggested that each company operating in the Gulf install adequate automatic instrumentation on its platforms to secure actual field measurements in the event of a storm. If such equipment had been installed on our platform, invaluable data for the design of future offshore structures might have been obtained. The committee is still considering this project and it is believed an agreement will soon be reached on blueprinting a research program.

The Ohio platform is in 47 feet of water at mean low tide. The height of the quarters structure deck and the main drilling platform above that datum is 26 feet. The height of the second deck, or mud-house deck, on the main platform, is 40 feet above mean low tide (14 feet above the main deck). Figure 3 shows the general features of construction and arrangements of the platform. Based on a water depth of 50 feet, it was not expected that a wave height of more than 32 feet would occur at the site of the platform, or that any wave crest (measured from datum to crest) would be over 16 feet, plus the storm tide. (See Table 1, Munk's table.) A maximum storm tide of two feet was expected in a 50-foot mean water depth. From the foregoing, the highest wave crest to be expected at the site of the platform was computed to be 18 feet above mean low tide. Wave crests at least eight or ten feet higher than expected were experienced during the hurricane. It is not possible to tell whether the wave crests or the storm tides were higher than computed.

The data used were derived from studies made on the Pacific Coast and, as is well known, that coast line has a very rapid fall from shore line to deep water, while the Gulf Coast has a gradual slope to the edge of the Continental shelf. It is believed that the latter condition might possibly have contributed to much higher storm tides than were computed by using present data to determine this factor. Our present knowledge of all the pertinent factors affecting this problem leaves much to be desired.

Our considered opinion respecting the actual happenings and resultant damage during the storm period at the platform is that the damaging waves occurred over a period of several hours, possibly six or eight; and with a possible minimum of three hours duration. It is believed unlikely that one or two exceptionally high waves did all the damage, although it is known that, under certain freakish conditions, wave intervals vary so that two or more waves might combine forces to form a single abnormally high crest; or they might combine to diminish one another so as to cause an exceptionally low crest. Numerous small broken pieces of decking lumber remaining on the platform after the storm offer evidence to substantiate this belief. Waves occurring at intervals of 14 to 15 seconds for a period of two hours' duration or longer and causing 500 or more crests to break just under or at the level of the main platform could (and probably did) cause damage, moving the machinery and houses only fractions of an inch at a time and eventually causing them to topple as the main deck support was torn away and the welds tying down the houses were broken.

The Stanolind Oil & Gas Company platform in the Gulf between Galveston and Freeport and about 45 miles northeast of our platform has a height of 33 feet above mean low tide, seven feet higher than our platform. Stanolind experienced no damage on the main deck from wave action. Fortunately for Stanolind the height of this platform as determined by the requirements of the LST drilling barge was higher than was generally regarded as necessary. Our platform was closer to the hurricane's eye, where higher wind velocities prevailed; however, the Stanolind platform was also in its path and at such a distance from the eye as to afford a greater fetch, which should have produced about the same wave crests. Because of its


MAP FOR
HURRICANE PLOTTING
GULF OF MEXICO
&
CARIBBEAN
THE DOW CHEMICAL COMPANY
FREEPORT, TEXAS
AUGUST STORM TRACKS STRIKING COAST WEST OF LONGITUDE 90°, AND PATH OF OCT. 1949 HURRICANE, PLOTTED ON DOW CHEMICAL BLANK MAP BY THE OHIO OIL CO.
KEY TO THE AUGUST STORM TRACKS OF WATERS AS SHOWN UPON THIS CHART
NO. DATES BEGINS NEAR
I AUG 27-29, 1926 17°N 79°W
II " 28-SEP 3, 1933 18°N 83°W
III " 28-SEP 5, 1935 18°N 83°W
IV " 26-SEP 1, 1936 27½N 85°W
V " 10-16, 1938 11°N 61°W
VI " 23-28, 1938 10°N 74°W
VII " 2-8, 1940 31°N 79°W
VIII " 21-30, 1942 14°N 60°W
IX " 24-29, 1945 19°N 82°W
TROPIC OF CANCER
BAHAMA ISLANDS
HAITI
PORT AU PRINCE
JAMAICA
KINGSTON
CUBA
HABANA
ISLE OF PINES
GRAND CAYMAN
CARIBBEAN SEA
VENEZUELA
CARACAS
Gulf of Venezuela
Yucatan Channel
YUCATAN PENINSULA
CENTRAL AMERICA
Merida
Veracruz
Tampico
Key West
Tampa
JACKSONVILLE
PENSACOLA
GEORGIA
FLORIDA
ALABAMA
MISSISSIPPI
LOUISIANA
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Morgan
Avery Is.
Burns
Wine Island
Port Arthur
Sabine Pass
High Is.
Galveston
Houston
Moss Bluff
Port Lavaca
Aransas Pass
Bishop
Corpus Christi
Sarita
Port Isabel
GULF OF MEXICO
N
S
E
W

FIGURE 4

seven-foot advantage in elevation, damage to the Stanolind platform was limited to that occurring below the main deck. It is known that in the immediate area of a hurricane (as both these platforms were), the height and period of the waves vary only slightly with different combinations of wind speed and corresponding fetch. Because of this fact, it may be concluded that we would have suffered only minor damage in this particular hurricane (which, it is generally agreed, was not of major intensity) had our platform been five to seven feet higher than it was.

Wind forces acting against a stationary object such as a drilling platform standing in the open sea become insignificant when compared with the tremendous pressures exerted by the accompanying wave action. Wind damage at our platform was limited to loss of a few sheets of galvanized corrugated iron off the engine shed and the tearing and deformation of the thin aluminum walls on one side and at both ends of the dry mud storage building. No waves reached the upper deck level where the shed and mud storage buildings stood. The minor damage at that level was caused by wind.

On the lower or main deck evidence was found that might cause one to conclude that at least four waves passed over the deck level. These waves combined with wind forces were of sufficient magnitude to move an upright 295-barrel welded steel tank containing 250 barrels of water for a distance of 5, 1¼, 2, and 8 inches, respectively. (This is substantiated by semi-circular marks cut into the decking by the edge of the manhole cover on the tank as it fell when each wave receded.)

A study of a report[1] pertaining to a previous drilling site southwest of the town of Palacios, Matagorda County, Texas, shows that only one known wave more than 27 feet high was experienced in this area from 1898 to 1939. A further study of the upper Gulf Coast of Mexico[2] shows that 64 hurricanes or tropical storms passed through this area in the same 41-year period. These hurricanes ordinarily do not exceed 50 miles in width, but winds of gale force usually extend 200 miles or more from the eyes or storm centers. The forward movement has rarely exceeded 10 to 15 miles per hour. Figure 4 shows the incidence and paths of hurricanes striking the coast west of Longitude 90 during the month of August over a period of 20 years, 1926 to 1945, inclusive.

A deep-water wave[3] moving into shallow water causes the forward speed of the wave to be checked by the ocean floor contour and resulting "pile-up" or fast increase in wave height is experienced. Should other obstructions such as rocks, reefs, or a drilling platform be in the path of such waves, further "pile-up" is occasioned. Storm tides are caused by extreme variations in atmospheric pressure combining with wind action and the "pile-up" phenomenon. Strong currents also extend the wave height. It is reported[3] that the water level on one observed occasion rose at the rate of 1.4 feet per hour to a height of 15 feet above mean low water level. From the foregoing, one may conclude that the less obstruction, the lower the waves and that round piling offers less resistance to wave "pile-up" than square piling.

Because of the "pile-up" phenomenon it is necessary to have some knowledge of the ocean floor surrounding the drilling site before erection of the platform is started. Thereby the probable maximum wave height as affected by local conditions could be predicted, and the drilling platform erected to the height considered safe for the area.

It can be observed from a study of the Pilot Chart of Central American Waters, No. 3500, an excerpt from which is attached as Figure 1, that three currents converge, or tend to do so, in the vicinity of our platform. Considerable difficulty was experienced with quite severe currents during the erection of the platform this past summer. The salvage work was delayed on several occasions because of these currents, which make it impossible for a diver to work on the ocean floor except for a few hours each day. The strongest current parallels the shore for most of the year and the second current merges with it in the vicinity of the platform at angles varying from month to month between 30 and 90 degrees—causing an unusually turbulent sea where they meet. A third current originating in the Sigsbee Deep extends north-northeast into the area but tends to change direction more often than do the two stronger currents.

The hurricane season is considered to extend from the month of June to mid-October. Rough seas and weather are experienced from early November into March and April. The calmer period extends over the intervening months, but after June may be broken by local squalls and hurricanes. In the case of drilling barges, as much as 15 percent of the drilling time has been lost due to adverse weather conditions, while lost time on completely equipped drilling platforms has averaged approximately one percent. In the erection or dismantling of a drilling structure, we have experienced a time loss of over 38 percent due to adverse weather conditions.

The standard weather forecast does not contain all the information an offshore operator desires or needs, especially as regards the state of the sea. It has been noted many times during the past year that small craft warnings would be hoisted in the Galveston area while a relatively calm sea prevailed at both our drilling platform and terminal. At other times, a moderate weather forecast would find the water in these vicinities much too rough to load or unload a cargo boat. This was due to the wide general area covered by the standard weather forecasts, which do not allow for variations in the much smaller area confined to our shore installation and offshore drilling platform. It is hoped that our radar equipment will aid us in locating local distrubances such as line squalls, and in more accurately determining weather conditions to be expected, on a short time basis, in the immediate vicinity of our platform.

Everything considered, there was comparatively little major structural damage to our main drilling platform; by far the most expensive damage was the loss of the quarters and galley houses and damage to their supporting structure. It is believed some of the damage to the main platform was caused by the bunkhouse striking against the end of the structure after it was washed into the sea. Although there are some details yet to be cleared up in regard to the final tabulation of damage realized, the following figures cover their cost insofar as can be ascertained at this time.

Cost of tangible materials lost	$ 94,094.57
It is estimated that the intangible cost to Ohio under its contract for repairing damages is approximately	101,000.00
Reimbursement for labor for drilling contractor's employes, approximately.	4,500.00
Cost for the use of drilling contractor's boats used solely in repairing the platform, which Ohio is obligated to pay	6,000.00
Total	$205,594.57

As our insurance policy covered only the platform and not supplies and equipment, the above figures do not include such items as furniture and fixtures, water tanks, butane tanks, and anchors. These items will amount to approximately $3,000.00. Several other minor items such as fencing, repainting, and damage to equipment suffered by independent well-servicing companies will be added to the total cost.

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[3] Bates, Charles C., and Glenn, Alfred G., Oceanography in the Offshore Drilling Campaign, World Oil, Vol. 127, No. 13, p. 114, 1948 (April).

[4] Cline, I. M., Tropical Hurricanes.

[5] Munk, Dr. Walter H., Wave Characteristics near Galveston, Texas. Wave Action on Structures.

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● American Iron Tubing Tool Joints are designed for use on tubing when it is used for completion, workover and deepening. In these joints the outside diameter and inside diameter of the tubing tool joint is the same as the outside diameter of the tubing coupling and the inside diameter of the tubing (as shown at right).

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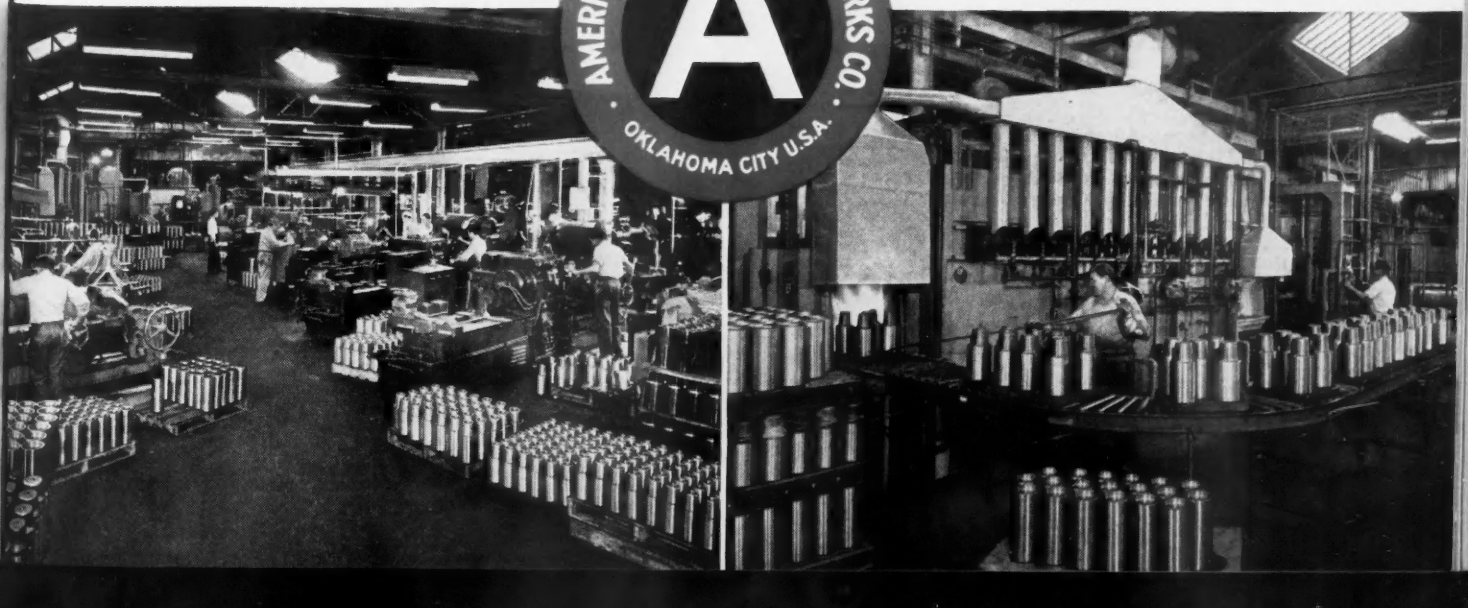


FIGURE 1

Portable Automatic Hard-Facing of *Drill Pipe Tool Joints*

By J. G. WATSON, JR. and H. N. KEENER
Process Engineering Company of Fort Worth, Inc.

IN TOO many instances depositing weld metal on tool joints has been termed "rebuilding." Rebuilding at least implies replacing strength and dimension to the joint. It is our intention to maintain the tool joint's necessary structural rigidity by applying protective material, while all critical sections are still above the minimum required for drilling.

Many years of experience in combating tool joint wear has established the value of hard-facing material applied at the proper time. Mobile mechanization, with its inherent accurate control, greater economies and more versatile application, has found a definite place in the continuous struggle to accomplish more at the same cost, or the same at less cost.

The equipment and method described was introduced to the field in October, 1948. Since that time many thousand feet of drill pipe have been protected through portable automatic hard-facing. It has been applied to all types of joints, including more than 25 strings of shrink-grip. Shrink-grip joints can be hard-faced on the pipe, without destroying the removable feature.

The entire equipment is mounted on a skid measuring 7½ by 10 feet and weighing about 2½ tons. It is transported by a suitable winch equipped truck (Figure 1). Welding and auxiliary power are supplied by converting a standard 400-amp. gasoline driven generator with specially constructed auxiliary equipment. Dollies which permit lengthwise as well as rotative movement are fastened to the customer's sills.

The operation consists essentially of preheating to 400° F. followed by an automatic welding operation in which an extended helix is employed. This permits the forming of grooves to receive the tungsten carbide as well as minimizing the heat effect by better

FIGURE 1 (Top of page): All equipment is on this 7½x10-foot skid. The collapsible, aluminum-sheeted doghouse opens on all sides. Its telescoping columns elevate for head clearance on the job. Road clearance is under ten feet loaded.

FIGURE 2 (Right): A discarded API joint, processed and sectioned to show the hard-facing deposit.

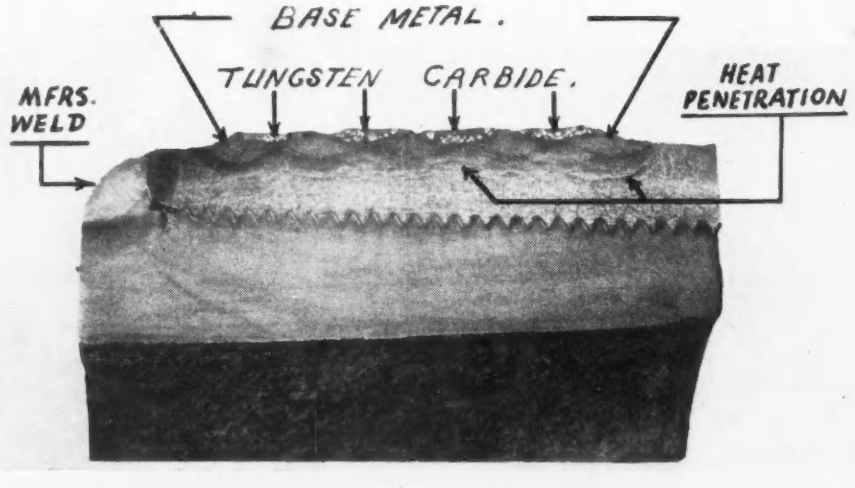


FIGURE 3. A sloping shoulder tool joint, badly worn elevator shoulder, only.

FIGURE 4. Same tool joint as in Figure 3, after building up the shoulder under submerged arc with 45/50 Rockwell "C" hard-facing metal.

FIGURE 5. Most common application. Five base metal bands overlaid with four bands of tungsten carbide. Photo shows start and stop points. This joint had all the factory applied bands worn off, except one at the elevator shoulder. Note freedom from undercutting, where base metal bonds to the tool joint.

distribution. The base metal or first pass of bands is always under submerged arc to prevent any undercutting and provides a clean, dense, hard material upon which the tungsten carbide is applied.

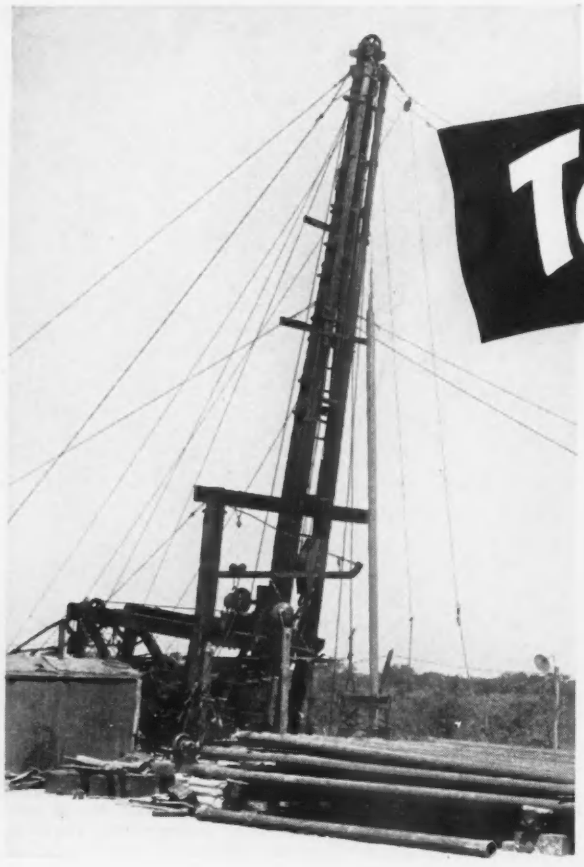
After welding and removing from the machine, the end of the pipe is covered to obtain better stress distribution by slow cooling. The entire welding operation (six to nine minutes) has been so fast and well controlled that only a small depth under the weld pad has reached a temperature above the tool joint manufacturer's draw temperature. The threads are later wire brushed for redoping with grease.

Since the invention of the submerged arc process it has been an established fact that submerging the weld puddle in flux had a marked improvement on weld quality. Undercutting with its notch effect, so detrimental to high strength steels, is completely eliminated. It has also been established that tungsten carbide should be deposited in a groove to obtain optimum results. Building continuous helical grooves of hard metal is believed to mark an innovation in the hard-facing of tool joints. Advantages of the process appear to be as follows:

1. The hard, groove forming metal, (base metal) itself a hard-facing alloy, does not undercut or wash.
2. Base metal deposited under submerged arc gives dense, slag free surface, for further deposits.
3. Continuous grooves eliminate the start-stop points common to one pass operations.
4. Helical grooves eliminate the necessity for lengthwise strips to prevent cutting out of bands.
5. Extended helix deposit in less than one minute per revolution permits field application of hard-facing to all types of tool joints.
6. The forming of helical grooves above the tool joint surface brings the hard-facing out into protective contact to the critical shoulders of the tool joint.
7. Uniformity of the continuous helix deposited under automatic control improves smoothness of deposit for maximum wear protection and safety.

Automatic submerged arc combined with the extended helical feed opens up many possibilities to tool joint hard-facing, formerly unsafe or economically impractical. As noted in the etched sample (Figure 2) the heat penetration is shallow and uniform. This permits application to shrink-type joints without destroying the removable feature. Hard-facing of standard API tool joints is also practical under this process. Automatic submerged arc welding of hard-facing has proven an excellent way to prevent elevator shoulders of the box from becoming unfit for service. Figure 3 illustrates a sloping shoulder type tool joint that has worn almost square. This was repaired by filling in under submerged arc (Figure 4), and touching up where necessary with a grinder to prevent elevator interference. Here again the submerged arc, free of undercutting, permits the shoulder to be built up harder than the original. Square shoulder joints are similarly protected when necessary. Portable automatic hard-facing offers an excellent way to reduce drilling costs in many instances. It not only permits extending the drill stem life in small increments as compared to new tool joints, but also permits a selection within the facing price. The most common application such as Figure 5 (five base bands, four tungsten bands) costs about 16 to 20 percent as much as a new joint, whereas a similar pad of 45/50 Rockwell C hard-facing material can be applied for 12 to 16 percent of new tool joint cost. Lower cost materials are advantageous when the expected remaining life of the pipe is small or abrasion very moderate. Under the present system all transportation costs are eliminated. Production rate also often affects the economics of hard-facing. Normal production is 40 to 50 ends per day. This is usually faster than the pipe is needed, which permits the hard-facing to be done while changing locations.

Combating wear, like corrosion, is a constant struggle to improve. Development of improved hard-facing materials will provide improved wear resistance to customer, where and when he wants it.



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Advance Preparation *for a* Casing Job

By GLEN D. HUGHES
Production Superintendent,
Sun Oil Company

THE PURPOSE of this discussion is not to go into the technical details of a casing job. It is intended only to call to the attention of those directly responsible for the success of the job a few points that will make the job run smoother, save time, and in some cases probably prevent a failure due to lost time.

SUCCESSFUL running of a string of casing depends on the proper functioning of the entire drilling rig. Though the rig has functioned perfectly during the drilling of the well, a few minutes spent checking it before the pipe is started might pay huge dividends. A few minutes spent raising the chain guards could display a drive chain ready to fail. Are the clutches working properly? Be sure, do not guess. Are all engine throttles and controls in good safe working condition? Rigs have run away and caused considerable damage, both human and material, due to the failure of the throttles and controls. The mud pumps should be checked. Are the valves and pistons in condition to bump the plug? Are the mud lines in such condition that they will hold the pressure necessary to bump the plug? How about the drilling line? Is it safe and in condition to complete the job?

If blowout preventers are used have they been checked lately to see that they function properly? Are they equipped with the proper size rams for the diameter casing being run?

A casing job may be called successful

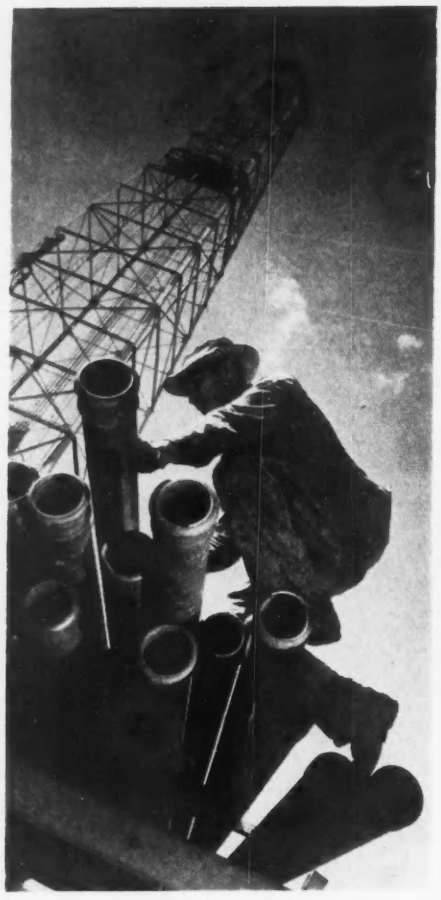
when the pipe has been run to the desired depth and properly cemented. For these two requirements to be met the well must be in condition before the pipe is started. In order to insure setting the pipe at the proper depth, time should be taken to secure accurate measurements of the total depth. When it is desired to set pipe on top of the producing zone, it is certainly necessary to have an accurate measurement of the top of that zone.

Measuring Drill Pipe

It is not the intention here to recommend any given method of measuring drill pipe, but only to make the statement that whatever method is used, be consistent and use the same method for measuring all pipe on a given job. The drill pipe should be measured several times during the course of drilling the well. This will eliminate having to correct sample tops, etc. Drill pipe should always be measured out and in the hole before coring, and to secure an accurate total depth and also to check the electric log measurements, the drill pipe should be measured out of the hole on the last trip.

To fulfill the second requirement of a successful casing job, the well must be in such condition that the pipe can be run to the desired depth and cemented. Here again it is not the intention to set up a mud conditioning program, but merely to state that the mud should be of such quality as to permit the pipe reaching the desired depth without interference from cuttings, thick mud cake, and bridges in the hole. Further, the mud should be of such quality as to permit ease of circulation from bottom, which will help insure a successful cement job.

Small articles of equipment often are forgotten or overlooked before the pipe is started; then when their use becomes necessary, in all probability a shutdown period is necessary before they can be located or hooked up. Before a casing job is started, an alert drilling superintendent or tool pusher will check to see that his make-up tongs are in first class shape and also that the necessary extra jaws are present and extra keys for the tongs are available in the tool house. He will see that the proper size slips are on the job and in condition to be used. His elevators and bails will be of the proper size and he will know that the latch on the elevators will function properly. Much time is lost looking for link bolts for elevators. The spinning rope or chain should be new or in good condition. The stabbing board should be checked for size and condition of safety before it is necessary to use it. Sufficient thread compound and applicator (paint brush is



good) should be available. A thread file is a handy tool to have present during the running of casing. The fill-up line should be hooked up properly before the casing is started. If this is done the minimum of time will be lost filling the casing at regular intervals.

Normally, the pipe to be run will be delivered to the well site in advance of the time that it is to be run. After the pipe has been placed on the rack, there are several steps that should be taken in order to eliminate confusion during the running of it. The joints should be counted to make certain that the proper number have been delivered. Knowing the exact number of joints on the rack will aid during tallying of the pipe.

The possibility of a joint being damaged during transit is ever present. Locating a damaged joint on the rack is much simpler and less expensive than discovering one in the well; consequently, good practice would dictate the running of a gauge (rabbit) through each joint before it is run into the well.

After the gauge has been run and bad joints marked or removed from the string, all protectors should be loosened. Collar protectors should be removed while pipe is on the rack.

Accurate measurement of each joint of pipe on the rack is essential if a successful casing job is to be had. In order to eliminate any doubt as to the identity of a given joint of pipe, each joint should be numbered before it is measured. The joints may be numbered very satisfactorily by using yellow lumber crayon. If the joints are numbered before they are measured it is an easy matter to locate their length in the pipe tally book should it become necessary to eliminate a joint from the string.

Ample Water

Ample water should be available for mixing the cement. Facilities for delivering the water to the cementing truck should be checked to make certain that the desired quantity can be delivered as required, before the casing is started.

The key to a quick, efficient and safe casing job is advance planning and preparation.

The following items should be checked before casing is started:

1. Drilling Rig.
   - (a) All chains.
   - (b) Clutches.
   - (c) Throttles and controls.
   - (d) Drilling line.
2. Mud Pumps.
   - (a) Valves and pistons.
   - (b) Mud lines—for leaks.
   - (c) Suction strainers—clean if necessary.
3. Blowout Preventers (if used).
   - (a) Proper size rams.
   - (b) Operate preventer.
   - (c) On pressure operated—check control lines for leaks.
4. Small Equipment.
   - (a) Make-up tongs—extra dies for tongs.
   - (b) Slips and elevators—proper size and condition.
   - (c) Thread compound and applicator.
   - (d) Thread file.
   - (e) Spinning chain or rope—condition.
   - (f) Stabbing board — size — condition.
   - (g) Pipe buggy and runway.
   - (h) Connect fill-up line.
   - (i) Casing pick up rope or elevators.
5. Casing.
   - (a) Count joints.
   - (b) Run gauge through joints.
   - (c) Loosen protectors.
   - (d) Number joints (yellow lumber crayon).
   - (e) Measure pipe.
6. Water Supply.
   - (a) Sufficient for mixing cement.
   - (b) Facilities for delivering desired quantity to cementing truck.

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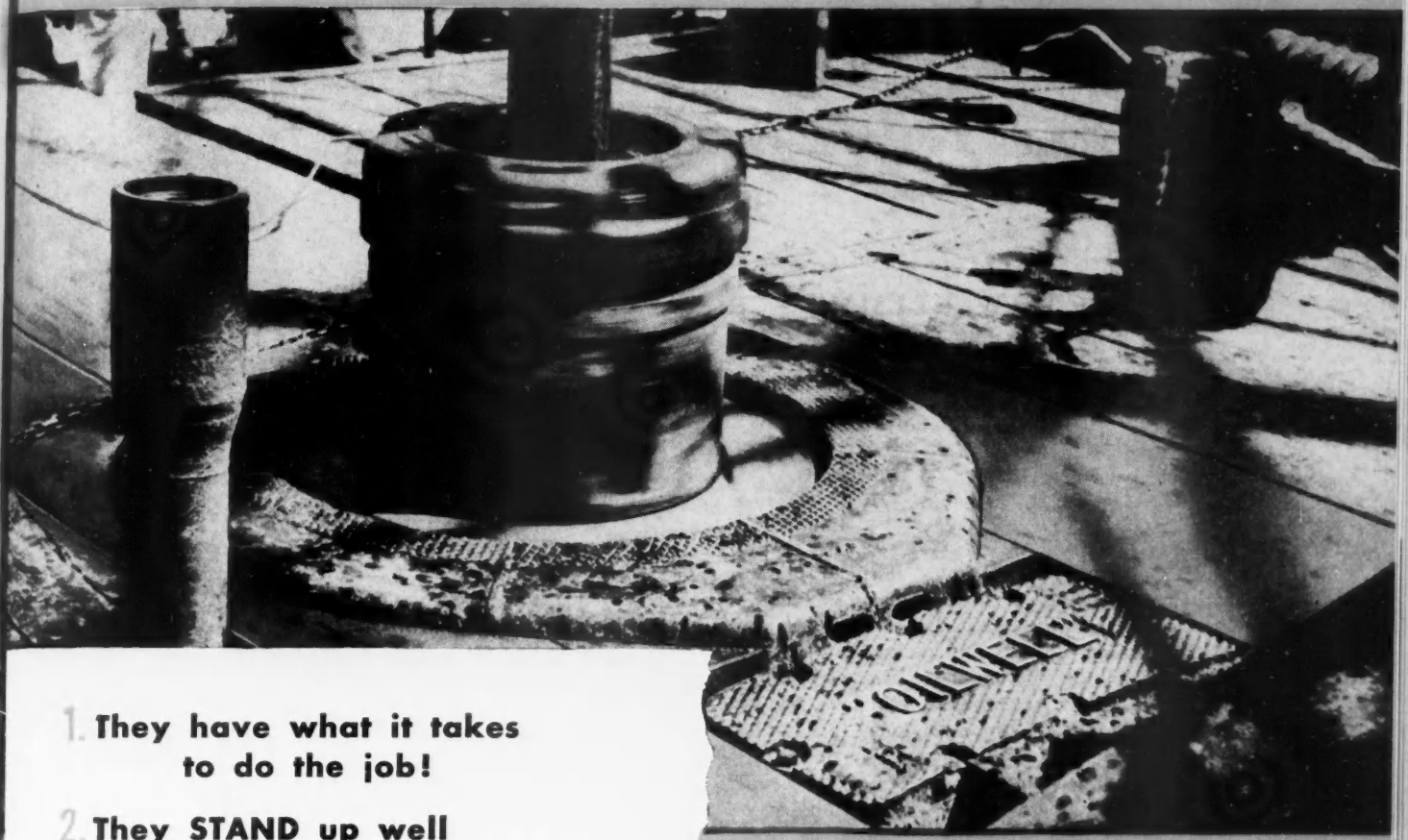

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Maximum Recommended Drill-Depth . . . . feet	9,000	9,000	13,000	17,000	17,000
Maximum Recommended Table Speed . . . r.p.m.	500	500	500	1000	500
Gear Ratio	3.28:1	3.28:1	3.82:1	2.61:1	3.84:1

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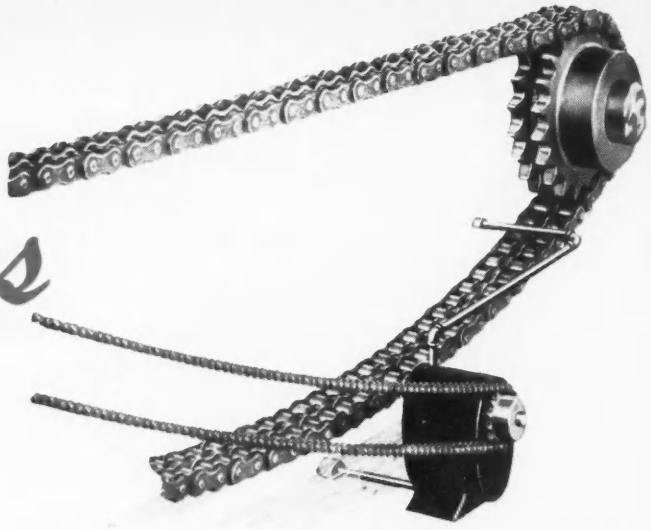

FIGURE 1. Method for providing force-feed lubrication on inside of high-speed chain, where centrifugal force will insure penetration.

THE life of a properly designed and constructed chain drive depends largely on the care it receives. Even with the best protection against foreign materials and with plenty of good oil, the steel mating surfaces of a chain wear or abrade. Where the loads and resulting pressure between the mating parts are light, the rate of wear or abrading effect is slow and the chain belt will operate many thousand hours before this wear produces sufficient elongation in the chain to warrant replacing it.

Under heavier loading, the resulting bearing pressure between the mating parts can reach a magnitude where it is difficult to maintain an oil film between the metal surfaces and the abrading will take place at a rate which can necessitate replacing the chain in a relatively short time. Under these heavy loads it is most important to assure an ample supply of good clean oil getting into the working surfaces of the chain. This is not always easy to do.

An excellent way to supply oil to a chain is to jet it onto the chain with a force feed pump. By placing the oil between a bushing sidebar and a pin sidebar on the inside of the chain, the oil will be centrifuged past the chain pin as it is flexed over the sprocket and will thus find its way into the space or clearance between the pin and the bushing. Oil placed on the outside of a chain would merely be centrifuged off the chain as it is flexed over the sprocket and therefore it has little chance of reaching the inner working surfaces. This type of lubrication is required where chain speeds exceed 2000 feet per minute velocity.

Next in line as a suitable means of lubrication is an oil-bath system. Under this form of lubrication, the chain is permitted to dip in a reservoir of oil. The chain should never be submerged past the pitch line at any one point. This type of lubrication is required when chain velocities exceed 1000 fpm. However, it cannot be utilized at chain velocities above 2000 fpm as the windage caused by the chain does not permit the oil to contact the chain properly and many times at these higher velocities, the turbulence caused by dragging the chain through the oil will cause oxidation and overheating of the oil.

For chain velocities under 1000 fpm, a drip feed lubricator is usually adequate and for slow-speed drives (under 500 fpm), lubrication can many times be accomplished by merely brushing oil on the chain. A good grade of SAE 30 oil may be employed.

Occasionally, one will see heavy oils and greases being used on chains. These materials seldom reach the working parts of the chain and the only useful purpose they serve is to protect the external surface of the chain from corrosive elements. The proper weight of oil is important on a high speed chain drive. An oil of the proper weight not only provides a good lubricant between the chain pins and bushings, but also provides cushioning between these members. This becomes quite important on pulsating loads. If the oil is too light, both lubrication and the cushioning are impaired. If a drilling rig is being operated in sub-zero weather, it is desirable to use a light weight oil as this at least insures some oil getting into the chain joint whereas if the heavier oil is used under low temperatures, there is a good chance that no oil will be delivered to the chain joint. A reasonable rule to follow in selecting the weight of oil for your drilling rig is to use the same weight of oil as used in an automobile for the specific climate involved. An SAE 30 oil works very well in temperate climates.

THE AUTHOR outlines common abuses of oil field chain drives, and recommends practices which will result in longer life. Written in non-technical language, the article will serve as a guide for instructing the newcomer to the rig on the points to be most carefully watched when lubricating, servicing or replacing a chain drive.

Of equal importance to seeing that a good supply of oil is placed between the working surfaces of the chain, is the consideration of keeping foreign material out of this working surface. Most modern drilling equipment is constructed with roller chain drives being totally enclosed. The drilling equipment manufacturer has thus fulfilled his obligation. With all drives totally enclosed, it is still quite possible to get abrasive materials into the working joint of the chain with the resulting shorter chain life. Dirt and dust will find their way through the openings and eventually the oil in these cases will become contaminated to the point where it should be replaced with clean oil. Some rigs provide an oil cleaner in their force feed system. Drilling equipment operators should insist that all access points to these cases be kept tightly closed at all times. They should also insist that chains, when removed from these cases, be protected carefully against dirt and corrosive elements. When most rigs are being moved, some chains must be uncoupled, and it is not uncommon for these chain belts to be thrown in the dirt. Some of these chains are carefully cleaned with kerosine and re-oiled before they are put into operation, but many are

not. The working surfaces of a chain belt are series of close fitting journal bearings with hardened and ground mating surfaces and with clearances measured in thousandths of an inch. Chain bearings should be treated with the same care and consideration as the bearings of the power units used on drilling equipment.

Most chain manufacturers box oil field chains and many supply stores are careful to keep these precision chains protected from dirt and corrosive elements. Insist upon receiving clean chain from your supply store and if dirty, dusty chain is received, be sure that it is properly cleaned with kerosine and soaked in a good grade of SAE 30 oil before it is put on the drive. This will insure the chain adequate lubrication during the first few minutes it is under load. From that point on, the oiling system will take over and insure the chain being properly broken in.

Chains used in the oil field all have highly finished surfaces on the pin and bushing. Corrosive materials such as acids in drilling mud, salt water or moisture in sufficient quantities will cause these highly finished surfaces to corrode. If this is permitted to any great extent, the pins undergo a change termed "corrosion embrittlement." After the chain pins have gone through this change, they will not stand as much shock loading as they would originally. This can be a cause of pins breaking.

One more place where operators can help themselves in obtaining longer chain life is to make sure that the chain is not hitting against an obstruction. Under steady non-pulsating loads, a reasonable amount of slack in a chain drive is not objectionable; however, oftentimes, slack is permitted to develop to point where the chain comes into contact with some structural member of the equipment. When this develops, one pitch of the chain should be removed to eliminate some of the slack, or if this is impossible, a support should be provided to permit the chain to slide easily over the interfering member. On long center drives such as the rotary table drive, it is not uncommon to support the chain on a wood member and this generally is considered good practice, providing, of course, the chain is permitted to slide smoothly over the surface of the wood support and is not dragged over a sharp cross member which would cause destructive wear on the chain.

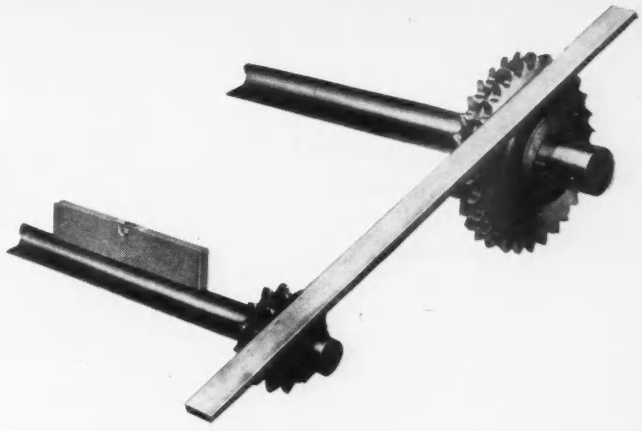

FIGURE 2. Methods for checking alignment and level of paired shafts for chain drive.

It is relatively easy to remove one pitch of chain from the API sizes since this chain is generally constructed with offset sidebars making each link or pitch a complete linkage in itself. American Standard roller chain is constructed with a straight sidebars and two pitches, comprised of a roller link and a pin link, are required to make up a complete linkage. Offset links are available for the American Standard roller chain series and it is good practice to include 2 to 2½ percent of these offset links in the average chain drive. The offset links will provide a means for shortening the chain by one pitch when slack develops and will also serve to indicate the approximate useful life left in a particular chain drive. On this basis, when the last offset link has been removed, there will usually be just about enough life left in the chain to permit time to secure a new drive and have it available. It is not good practice to insert an unworn offset link in a worn piece of chain as this makes a variation in pitch at that point. Under high speeds this could cause an undesirable condition. Therefore, insert the offset links in the chain when it is installed and remove the worn offsets as required.

Roller chains having all offset sidebars are available in 1¼, 1½, 1¾ and 2-inch pitch although all manufacturers do not make this series.

Discussion thus far has dealt mostly with considerations under the control of the operator of drilling equipment. Occasionally, chain life is impaired by conditions not normally under the control of the operator.

Misalignment of sprockets is undesirable and if severe will greatly shorten chain life. A simple way of checking sprocket-offset misalignment is illustrated. Occasionally, sprocket misalignment is due to shafts being non-parallel. Both types of misalignment should be checked carefully if chain shows signs of faulty alignment in operation.

Properly cut sprockets are important to the successful operation of high speed chain drives as employed on modern drilling equipment. Drilling equip-

TABLE 1
Trouble-shooting on chain drives

SYMPTOMS	POSSIBLE CAUSES	REMEDIES
Broken chain pins.	1. Sprockets too small for load imposed. 2. Worn on improperly cut sprockets. 3. Shock or suddenly applied loads. 4. Corrosion embrittlement.	1. Reduce load or use larger sprocket. 2. Replace worn sprockets and check tooth contour if suspected that sprocket is improperly cut. 3. Avoid shock loads. 4. Replace chain and protect from corrosive elements.
Broken chain rollers.	1. Excessive chain speeds. 2. Improperly cut sprocket.	1. Reduce speed or use shorter pitch chains. 2. Check sprocket to make sure roller is properly contacting the teeth and replace with proper sprock t if found defective.
Broken chain sidebars.	1. Misalignment. 2. Overload in fatigue range. 3. Shock or suddenly applied loads.	1. Check sprockets for offset and shafts for parallelism. 2 Reduce load or install heavier chain 3. Avoid shock loads.
Wear on side of chain sidebars and uneven wear of external surface of roller as well as sides of sprocket teeth	1. Misalignment.	1. Correct alignment.
Chain climbs sprockets.	1. Improperly cut sprockets. 2. Excessive chain elongation. 3. Stiff joints due to misalignment or poor lubrication.	1. Check tooth contour on sprocket and replace sprocket if necessary. 2. Install new chain. 3. Correct alignment or provide better lubrication.
Chain clings to sprockets.	1. Improperly cut or excessively worn sprockets. 2. Heavy or tacky lubricants.	1. Install new sprockets. 2. Clean chain and sprockets and lubricate correctly.
Chain whip.	1. Long centers or pulsating loads	1. Install idler, or support on which chain can slide, to dampen pulsation.
Losing cotters.	1. Vibration.	1. Eliminate vibration if possible, or install cotters.
Discolored pins. Scuffed pins.	1. Inadequate lubrication. 2. Wrong lubrication.	1. Provide more oil to working surfaces of the pin. 2. Use proper weight oil.

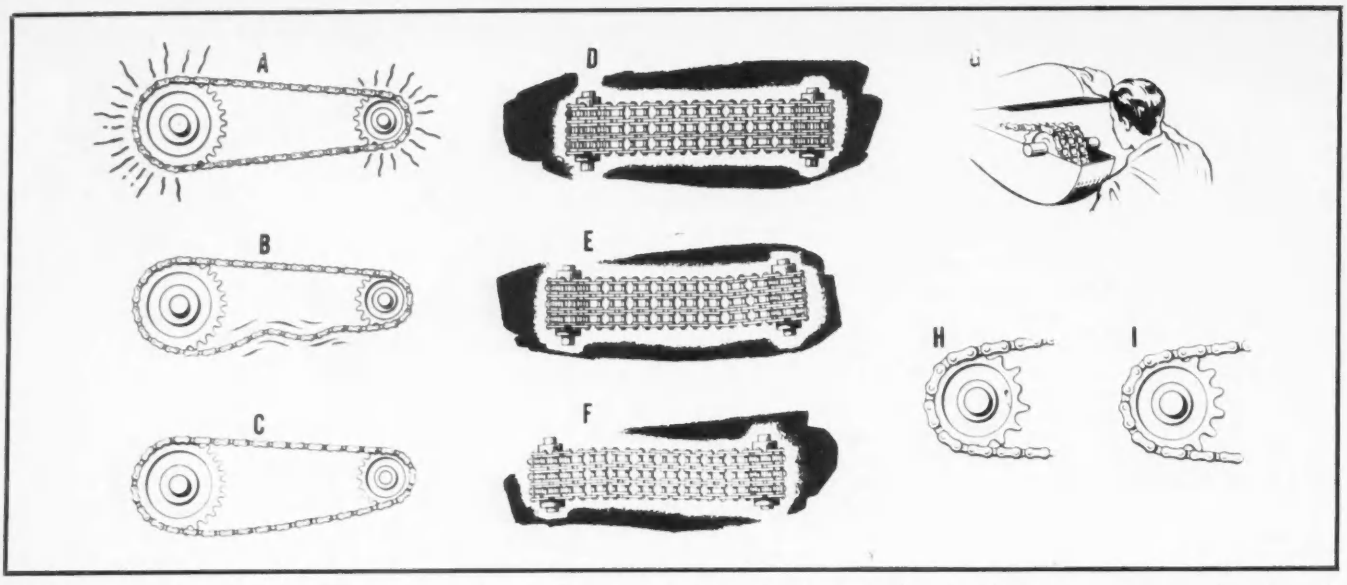

FIGURE 3. Inspection points in proper chain care. A shows chain too tight; B, chain too loose; and C, chain properly adjusted. D pictures shafts properly aligned, as compared with E, shafts not in alignment. In F, sprockets are not aligned, although they are on parallel shafts. G shows inspection of the chain while it is motionless. H shows worn sprocket, and I, new sprocket.

ment operators should insist upon well machined sprockets with machine cut teeth. Cast tooth or flame cut sprockets cannot possibly be made accurate enough to properly operate with chain drives running at speeds demanded by modern drilling equipment. Insist upon sprockets machine-finished by a reliable manufacturer of this type of equipment. Occasionally the statement is heard "a sprocket is a sprocket." It must be recognized that an improperly cut sprocket will not permit satisfactory chain life under the loads and speeds used on drilling equipment. The sprocket must be absolutely accurate and made to close tolerances. Many times an inspection of a sprocket after it has been in operation for some time will indicate the quality of the machine work on the sprocket tooth. The working surfaces of the teeth should become burnished uniformly with wear and this burnished surface should be apparent in that area slightly above the pitch line on both sides of the tooth. Many times there is not sufficient wear in the pocket of the tooth to produce a burnished surface. On sprockets for multiple width chains, this burnished effect should be apparent uniformly across each set of teeth.

A new chain should never be installed upon badly worn sprockets. It is impossible for a new chain to properly engage the teeth of a sprocket if it has become worn excessively and this can only result in shortened chain life.

Adequate number of teeth on a sprocket is important. A sprocket with 15 teeth or less in a drilling rig can be a serious handicap. Sprockets with teeth in the range of 16 to 20 are many times adequate, but sprockets on the higher side of this range are more desirable. Sprockets with teeth from 21 to 26 are the best ranges, but those with a greater number of teeth can be used and action will improve as the number of teeth increase; however, there is danger of extremely large sprockets resulting in excessively high chain velocity. Sprockets through 30 teeth are not uncommon in compound drives, and many times the larger sizes are required to accommodate the necessary bearings and shafting and generally sprockets of this range do not result in chain velocities beyond good operating limits.

Chain pitch is an important consideration in relation to the rpm of the sprocket. Common practice by drilling equipment manufacturers dictates the following approximate maximum rpm for the various pitches of chains in common use. These speeds are maximum with 21 to 24-tooth sprockets.

CHAIN PITCH	MAXIMUM RPM
1 inch	1,575
1¼ inches	1,150
1½ inches	900
1¾ inches	740
2 inches	625
2½ inches	465
3.075 inches	450
3.125 inches	450

In some cases, these speeds are exceeded by approximately 10 percent and occasionally drives exceed even that limit. However, this is not common practice. This higher rpm can cause excessive impact between the chain roller and the sprocket tooth and unless all conditions are ideal this can result in roller breakage and other destructive actions as well as extreme noise.

The following list will summarize some of the pertinent factors to be considered in operating chain drives:

1. Protect the highly finished surfaces of chain from corrosive elements as well as dirt and dust.
2. Supply working surfaces of the chain belt with plenty of clean oil of proper viscosity.
3. Do not overload chains.
4. Avoid shock loads generally caused by rapid engagement of clutches, etc.
5. Do not operate chains at speeds greater than recommended for the particular chain pitch and sprocket size involved.
6. Do not use worn sprockets or improperly cut sprockets.
7. Use sprockets having sufficient number of teeth.
8. Remove excessive slack. Do not permit chain to hit against obstacles.
9. Avoid misalignment of sprockets.

About the Author

W. W. KLEMME graduated from the University of Wisconsin in mechanical engineering in 1934 and in the following year joined the Chain Belt Company. Since his transfer to Dallas in 1942, he has specialized in the study of chain applications on drilling equipment. He is Dallas district manager for Chain Belt.

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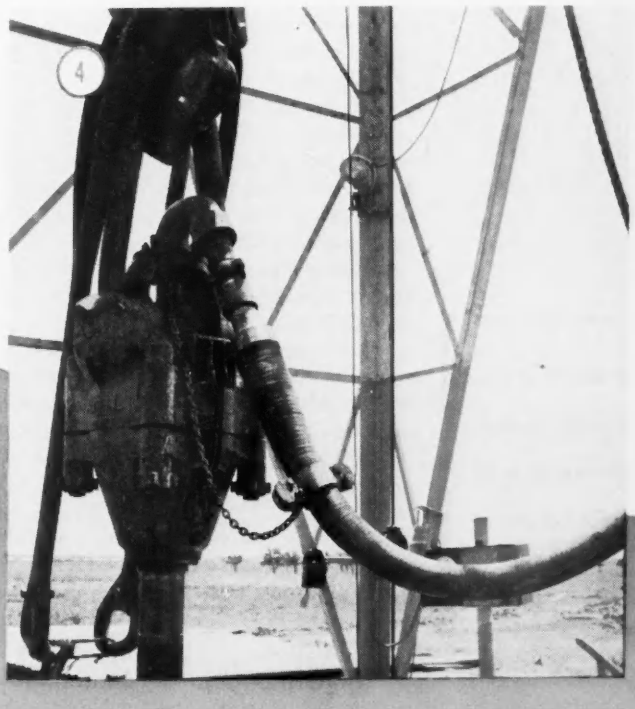

Plastics in Gas, Water Shutoffs

By J. F. McDONALD
District Engineer, Gulf Oil Corporation

PLASTICS have been used by the oil industry for gas and water shutoffs since 1940 with increasing success as the technique has been developed and applied with greater understanding by engineers and field men. As a rule the degree of success achieved is proportional to the consideration given to the condition of the well to be worked over, the planning of the job, and the objective to be attained. All too frequently jobs have been undertaken without considerations of the conditions that obtain and, as may be expected, result in failure or, at best, only partial success. Under such circumstances the product is not to blame; rather the poor judgment of those who were in charge of the operation.

Some factors to be considered before undertaking a gas or water shutoff job with plastics:

1. Condition of hole.
2. Size of hole.
3. Porosity, permeability, temperature and character of formation.
4. Gas/oil ratio; oil/water ratio.
5. Gas/oil contact; oil/water contact.
6. Type plastic best suited to achieve desired results.

Condition of the hole is of primary importance since most plastics will not set up in a homogeneous state when contaminated with mud. It is good practice to flow the well for a day or two before undertaking the job; or, if the well will not flow, to bail and swab until the formation has completely cleaned itself and there is no danger of mud contamination. In new holes it is necessary to kill the well, preferably with oil from the same formation or with salt water, whichever may best overcome formation pressure.

Accurate measurement of the well bore is necessary, and in open hole work it is obvious that the diameter of the hole be ascertained to prevent plastic entering and sealing off a portion of the sand unintentionally. Measurement of hole size involves an accurate caliper survey, and when this is known the quantity of plastic to be used in an open hole may be approximated by the following formula:

$$Q = \frac{\pi}{4} \times \frac{12}{231} \times [D^2 + (d^2 - D^2) \times P]$$

where Q = Quantity of plastic, gals./ft.
d = Diameter of penetration around bore hole—inches.
D = Diameter of bore or calipered hole—inches.
P = Percent porosity of formation.

This formula assumes ideal conditions of a symmetrical hole and uniform penetration throughout the section.

Character of Formation

The character of the formation may best be determined from visual examination and analysis of cores. Where cores are not available, shale breaks, limey streaks in sand, or sandy streaks in limestones may be located by electric logs or radioactivity surveys. It is of major importance to note, particularly, the position of impervious strata with respect to the gas, oil or water contact as will be brought out later.

Porosity and permeability of the formation obtained from core analyses are useful in determining the quantity of plastic to use and in estimating the depth of penetration which will produce desired results. Not only the horizontal, but also the vertical permeability should be considered. The closer the ratio of vertical to horizontal permeability approaches unity, the more exacting subsequent production practice must become for the plastic job to remain successful.

Determination of the formation temperature is important in order to select a plastic which will set up within the temperature range existing in the well. Satisfactory plastics are available which will set up in temperature ranges of from 70 to 300° F. The common method for obtaining formation temperature is to use a maximum recording thermometer run in a bomb encasement on a wire line to the depth opposite the formation to be treated. It is advisable to have the well in a static condition for a sufficient period to reach true formation temperature.

Bottom-hole pressure data are desirable in planning the job because of their relation to squeeze pressures and overburden pressures in establishing the limits at which the job may safely be performed.

Gas-oil and oil-water ratios obtained by flowing or pumping tests before and after the job are essential to determine the degree of success achieved in the shutoff operation.

Most important factors to be considered are the gas-oil contact, reduction of gas-oil ratio and the oil-water contact. These data may be obtained from core analyses and electric logs, and in their absence, by observation of samples, and penetration of the water zone in cable tool drilling.

From core analyses may be obtained information on water increase, decrease in oil, chlorides in the sand, increase or decrease in porosity and permeability, all of which are factors important in the over-all planning and success of the operation.

When the above information is thoroughly assembled and checked and the focal points definitely located, the selection of the most suitable plastic and the

THE AUTHOR DISCUSSES the use of plastics for shutoffs in various types of wells, and reviews the technique actually followed in seeing such a completion through under conditions as met on two different jobs. Careful planning and execution of every step of the process are required to enable accurate duplication to be made of successful closures.

technique to be applied must be decided upon. In this light, future operation of the well must be considered; that is, whether it will be necessary to re-open the formation or whether the job is to be designed to last for the life of the well. If re-opening all, or a portion of the formation is contemplated in the future it may be good practice to set a removable liner opposite the sand section. Such a liner may later be chemically dissolved or removed by milling, perforating, marble shooting or some other suitable means.

Plastics are now available that will provide deep or shallow penetration into the sand either pre-mixed or by addition of fillers.

New techniques to assure a successful operation are constantly being developed. Some pools provide problems to test the engineer's ingenuity. Water shutoff in a particular operation may be relatively easy, while the problem of shutting off gas may be complex and difficult. In general, no two wells present absolutely identical conditions and in this respect success or failure depends on a thorough understanding of all important factors connected with the well.

The following examples presenting unique features are given to emphasize the necessity for applying good engineering and operational techniques. The jobs were undertaken in a small pool in Seminole County, Oklahoma.

The pool is producing from the Gilcrease sand and is a stratigraphic type pool closed on the south by a fault or steep folding; on the east by the sand shaling out; and on the north and west by structural elevation. A gas cap overlies approximately one-third of the pool having an average thickness of 9.5 feet with the oil-bearing sand being approximately 20 feet thick and underlain with water. Figure 1 is an east-west and north-south section through the pool showing the position of each zone. The discovery well "B" was completed in August, 1947. Figure 2 is an electric log of the discovery well "B" showing rather clearly a definite permeability break in approximately the middle of the sand caused by a small coal vein approximately one foot in thickness. The sand was logged at 3725 feet and seven-inch casing was set and cemented at 3727 feet. Initial production was 780 barrels of oil and 470 barrels of water per day flowing through 2⅞-inch outside diameter tubing and three-fourth-inch choke. Gas-oil ratio was 752/1. Flowing bottom-hole pressure tests indicated a capacity of 2360 barrels per day with a productivity index factor of 1.43.

After deciding to effect a water shutoff, the core analysis record was checked and revealed close agreement with the oil-water contact. It was noted that the

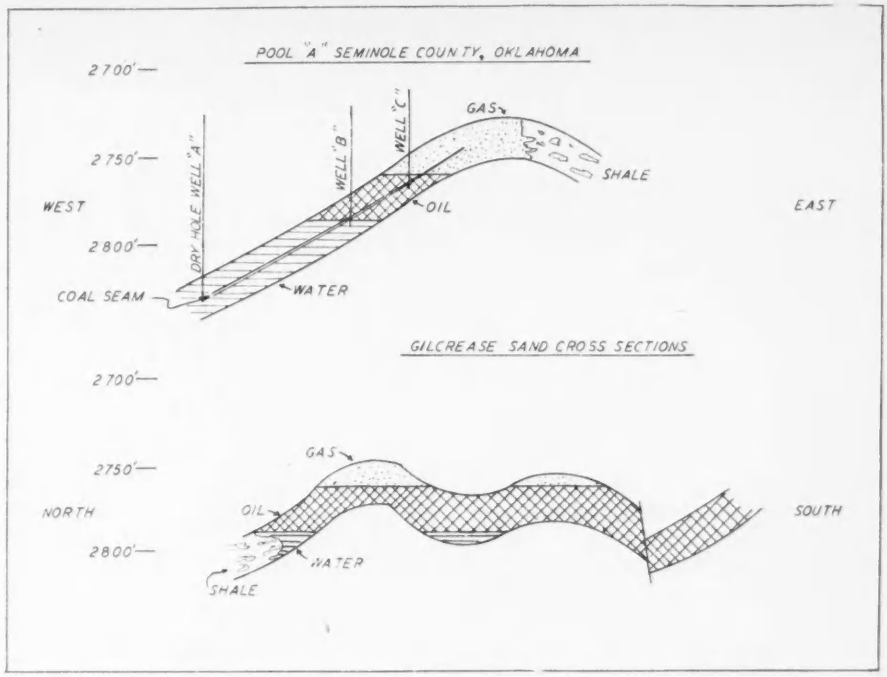

FIGURE 1

permeability (at the coal seam at 3741 feet) decreased to eight millidarcys with the chloride increasing below this point. The analysis further showed that the percent water doubled below 3741 feet and the percentage of oil decreased. With the coal seam forming a barrier, although not as good as shale because of fracture planes, it was decided to plug back to this point, squeezing most of the plastic below the coal seam at 3741 feet while at the same time having the plastic slightly cover the coal seam in the final plug back operation.

Using Plastic

After discussion with the service company representatives the job was undertaken as planned and it was decided to use a phenol-formaldehyde plastic. The well was killed with salt water and 16 gallons of plastic, without filler, dumped on bottom and squeezed at formation break-down pressure. After standing two hours it was found that 100 percent penetration had been obtained. A second stage of 19 gallons of the plastic, with filler, was dumped on bottom and squeezed for formation break-down pressure. This stage resulted in 100 percent fill-up to 3738 feet, two feet above the coal seam level, or one foot above the desired point. However, this excess was not considered harmful and tubing was re-run with perforations at 3732 feet, six feet above plug back depth. On 24-hour test started 12 hours after the plastic had set up the well flowed 628 barrels of oil, no water, and cutting 0.6 percent bottom sediment through 2⅜-inch OD tubing wide open. The flow was then regulated to pool allowable of 150 barrels per day. (Allowable was soon afterwards increased to 250 barrels of oil per well per day.)

Flowing bottom-hole pressure tests, one week after the plastic job was completed, indicated a capacity of 1435 barrels per day with productivity index of 0.835. Production tests throughout the period since treatment reveal the water production has gradually increased to 50 percent of the well fluid. Considering the type of sand, the nature of the coal barrier and the fact that the well, shortly after the shutoff operation, was pulled at the rate of 250 barrels per day, it is considered that the use of plastic in this remedial job was quite successful.

A gas shutoff job, in the same pool on well "C" (Figure 1) presented a more difficult problem. The sand was topped at 3699 feet and cored to 3726 feet, total depth, with the bottom of the sand logged at 3724½ feet. The coal seam extending in an east-west direction throughout the sand was approximately eight inches in thickness in this well and was encountered at 3711 feet. Visual observation of the cores indicated the portion above the coal seam, or from 3699 feet to 3711 feet, to be in the gas cap, with gas-oil contact being at the coal seam.

The visual observation was confirmed by the core analysis which revealed average oil saturation of 3 percent above 3711 feet and 15 percent below the seam to the bottom of the sand. A drill-stem test at 3705 feet total depth recovered gas only at the rate of 9000 Mcfd. At

3726 feet total depth, drill-stem test with the packer at 3711 feet recovered 58 barrels of oil and 1900 Mcfd. With these data, the gas-oil contact was definitely established at 3711 feet. Initial production through 2⅜-inch OD open tubing was gauged at 882 barrels oil per day and 6500 Mcfd, the gas-oil ratio being 7369/1.

Approximately one month after completion, at the allowable rate of 250 barrels oil per day, the gas-oil ratio had increased to 9600/1. In view of the dissipation of energy from the gas cap a normal plastic gas shutoff job was performed on the assumption that a poor cement job had been obtained. The well was filled with gravel and plastic cap to 3712 feet and the pipe perforated from 3706-11 feet with 24 holes. Then 30 gallons of plastic were equeezed above formation pressure around the shoe and through the perforations, obtaining 75 percent penetration. The well was then brought in through the tubing producing 285 barrels oil per day with a gas-oil ratio of 6330/1 or a reduction of only 3270 cubic feet per barrel, indicating that gas channeling was probably the cause of the still high gas-oil ratio.

Vertical permeability analysis of the sand was obtained and the core analysis indicated the vertical values were approximately 50 percent of the horizontal, particularly at the casing point of 3711 feet and at 3715 feet. This condition of the sand at the casing point and immediately below was particularly conducive to gas channeling from the gas cap when differential pressures across the formation were large as in the case of the high flowing rates.

In order to overcome the excessive gas-oil ratio it was necessary to set a liner through the sand and perforate only the lower four feet of the formation from 3724-20 feet to produce the well at solution gas ratio. However, the objective was to leave the sand undamaged and to leave the bore hole in such condition that the sand below the casing point could be re-opened at a later date, if such were necessary.

In planning the liner job, in view of these conditions, it was decided to use removable liner that could be easily and positively removed by chemicals, milling, or marble shooting. In selecting the plastic, one composed of calcium malamine and calcium sulfate was chosen for the following reasons:

1. The material is pumpable.
2. A non-porous plugging medium is produced.
3. The set volume, because of the calcium sulfate, is larger than the fluid volume.
4. Penetration, or invasion of the formation, is minimized.
5. The initial setting time may be closely controlled between one and four hours between the temperatures of 60 and 135° F.
6. Complete setting of the material may be obtained within eight hours.
7. The material is reportedly less affected by agitation and impurities than the phenol-formaldehyde types of plastics.

The technique of setting the liner and of running the plastic was as follows:

1. Kill well.
2. Clean out to bottom.
3. Run liner with washdown shoe and circulating subs on 2⅜-inch OD tubing.
4. Set liner on bottom.
5. Pump diesel fuel ahead of plastic (Type plastic used is soluble in water in liquid state).
6. Pump required amount of plastic.
7. Pump diesel fuel-oil behind plastic.
8. Displace all plastic behind liner using salt water.
9. Drop steel tripping ball to shear pins in shoe and establish circulation in liner.
10. Circulate all material out of annulus of tubing and liner and continue circulation for period sufficient to permit final set (Eight hours).
11. Back-off from liner and pull tubing.
12. Swab hole dry to test for complete shutoff.
13. Reload hole and perforate.
14. Run tubing and swab well in.
15. Test well.

The total elapsed time for the job on well "C" from rigging up to kill the well, to tearing down after swabbing-in amounted to 128 hours.

Production tests, after the liner-plastic job resulted in gas-oil ratio of 617, 665, 720, 890, and 787/1 for the five days immediately following the job. Six months after the job the ratio had increased to 1000/1. To date it has not been necessary to remove the removal liner or recondition the sand.

The technique in the first of the two jobs described is commonly followed in everyday phenol-formaldehyde plastic application. Its success, in this particular well, is attributed to the careful planning and physical execution of the work. The success of the second job described is attributed to the study of the factors involved and the selection of the proper materials to satisfactorily meet the conditions. The plastic field, although now readily accepted in oil field applications, has not been fully exploited. Further research and experimentation will not only improve existing methods but will broaden the range of application.

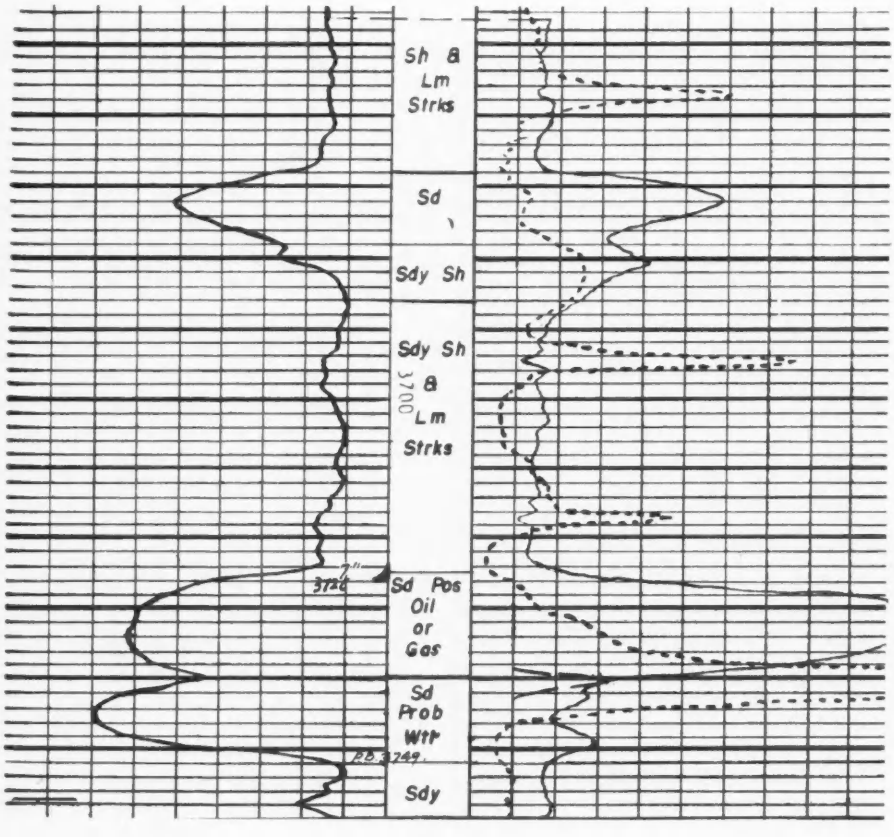

FIGURE 2

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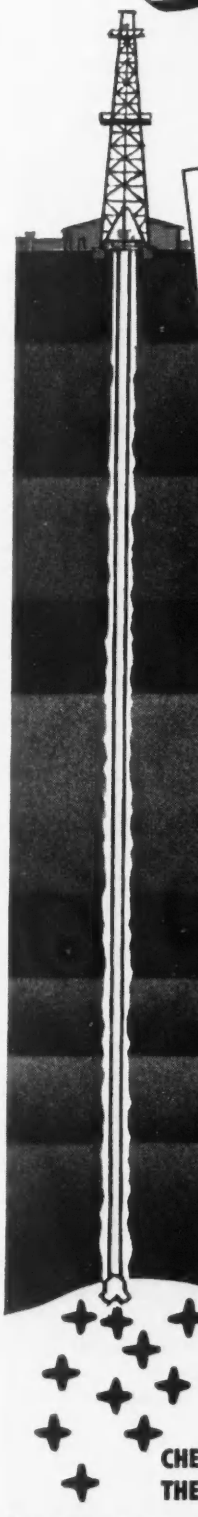

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By W. T. BOX and R. F. MEIKLEJOHN
Byron Jackson Company, Los Angeles

THE JET PROCESS has grown from the first commercial job, which was done in California in September, 1947, until now it represents perhaps 50 percent of the perforating done in the U. S. The technical improvements since the process was first offered to the oil industry are described in this article. The new developments that can be expected in the next year are briefly discussed. This paper covers the practical applications of the jet process. It describes the improvement in charge performance and shooting equipment. The application of the process to open-hole shooting is discussed, describing some of the field reactions and the future potential of this phase.

RESEARCH on the jet process is conveniently divided into three fields. The first is the design of charges used in the casing perforator. The work includes the improvement and redesign of existing jet perforators and the design of new charges to permit use of the jet process in all conventional casing strings. The second field is the improvement in the design of equipment to carry the charges to the shooting zone. This work is done by the various service companies operating under the basic patents. The last field of development is the work on new applications for the jet process. This has principally involved open-hole shooting and, to a limited degree, casing severing.

The advancements of most vital concern rest in the work done on the casing perforator, which consists of both charges and carriers. The most common charge seen today is the jet perforator (Figure 1). It consists of five major parts: the case, liner, explosive, booster and primacord ferrule. All charges used for perforating or open-hole shooting have these basic component parts in varying shapes and sizes. The carriers are most frequently referred to as guns. However, the word "carrier" better describes their true function, which is merely to carry the charge and a quantity of air to the shooting zone.

At a casual glance, as the general appearance of the charges and the carriers has remained the same, it would be easy to say that little work had been done since 1947. This is far from true. Most of the improvements realized are in the form of refinements, as the basic principles born at the time of introduction of the jet process to the oil industry have proven sound. There are two basic principles and their soundness is well established. The first is the firing of the charge through a small port in a thick-walled steel tube which contains the charges surrounded by air. The air, steel tube and small port will effectively absorb and confine the shock of the explosion and allow only controllable stresses to be applied on the casing being perforated. The second basic principle is the means of detonating the charges through an explosive cord which is in turn detonated by an electric blasting cap. By this method the detonation of the charges has been shown to be foolproof. The time lag between the firing of consecutive charges, which is a maximum of fifteen-millionths of a second, can be carefully controlled.

Throughout the course of this paper, performance of the charge will normally be expressed in penetration in a steel target. That this target does not duplicate well conditions is realized. The fact is known that steel target tests favor the jet process over bullets more than is actually realized in wells. It has been conclusively proven, however, that a charge which gives superior performance in steel will in turn give superior performance under actual well conditions. The conventional target of multiple casing strings cemented in a 55-gallon drum has been abandoned. This type of target will not contain the full path of the jet,

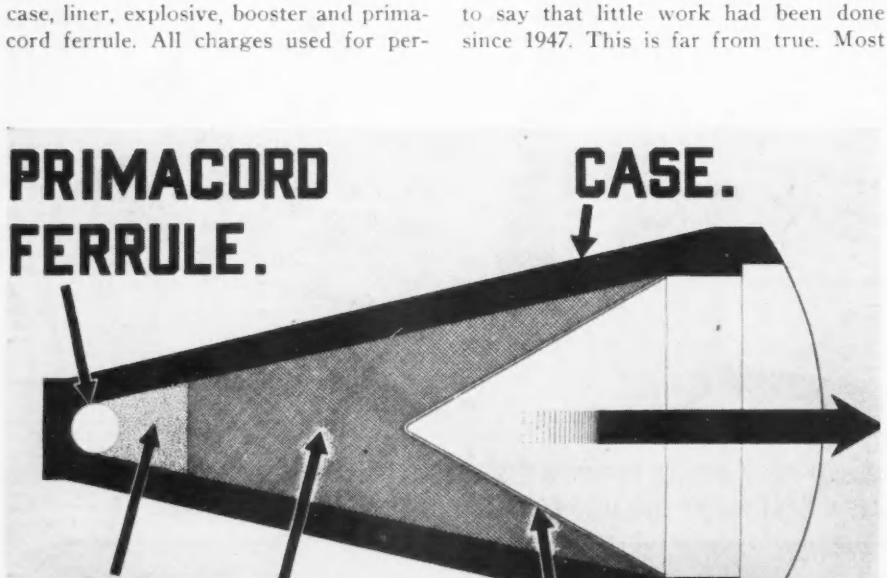
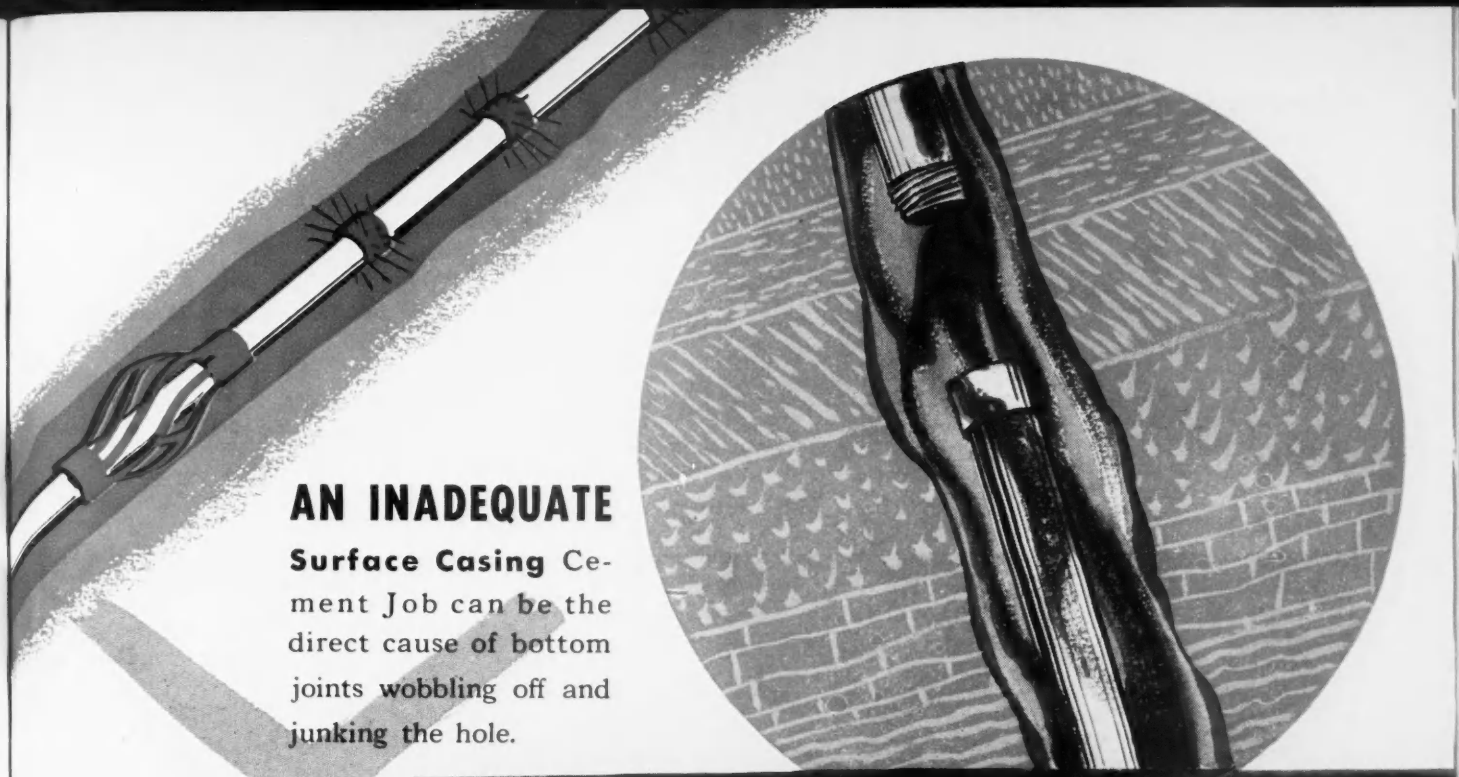


FIGURE 1. Diagram showing component parts of a lined shaped charge.



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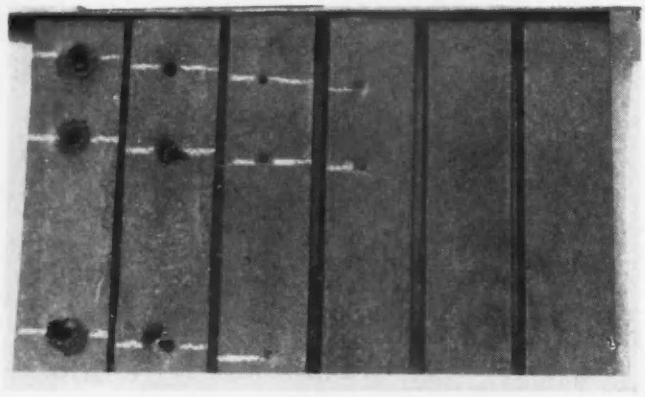
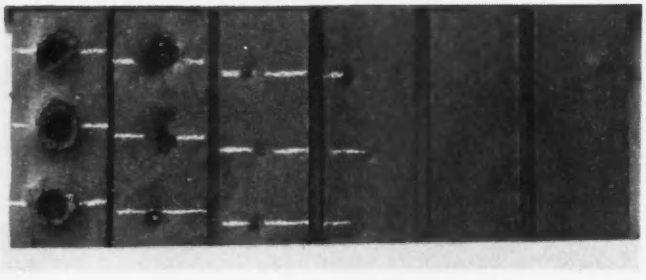


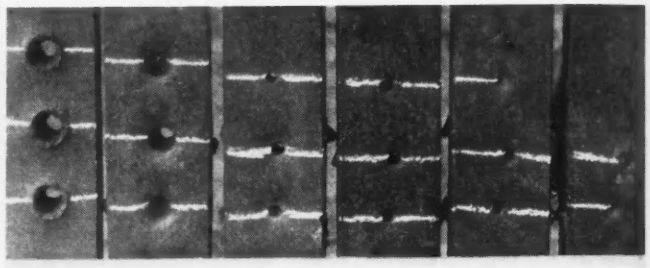
Penetration in one-inch bars showing the improvement in performance.

FIGURE 2 (top left): Report 206. Test 2. Charge, 28 gram. Pentolite load. Liner, 45° steel cone.

FIGURE 3 (lower left): Report 206. Test 3. Charge, 28 gram. Pressed RDX load. Liner, 45° steel cone.

FIGURE 4 (lower right): Report 206. Test 5. Charge, 28 gram. Pressed RDX load. Liner, 60° copper cone.





and a reproducible target exact in every respect is difficult. A homogeneous target of mild steel, fully annealed, blocks or bars is now used in all test work. With this type of target, data can be duplicated with a probable error of less than 2 percent, and improvements as small as 5 percent in performance can be detected.

One-Ounce Charge

In the field of charge design, the greatest advancement has been made in the one-ounce charge shown in Figure 1. This charge was made the first introduced and is the most popular size used today. It is run in a five-inch outside diameter and larger carrier and is used in 6⅝-inch and larger casing. The first charges were manufactured in California, using a relatively low temperature, 180° melting point explosive. The liner of these charges was made of mild steel, and this liner had a 45-degree included angle. The performance in the steel block test was 2.8 inches penetration, (Figure 2). Notice the smallness and irregular shape of the holes.

In October, 1947, a new charge was offered. It was identical to the earlier charge with the exception of the high temperature pressed explosive suitable for 350° for one hour. The first 100 wells were perforated with these charges which were used until the early part of 1948. Their performance of 3.2-inch penetration and the continuing ragged hole are shown on Figure 3.

From a survey of field results of these early jobs, contained in the paper, "Field Results of Jet Perforator Charges" by Robert Harcus, presented at the Pacific Coast Division, API Spring Meeting at Los Angeles, May 6, 1948, it was determined that the oil industry now had a tool which could reach out beyond man-made or natural barriers and obtain production when and where bullet perforating had failed. It is well to note that outstanding results were obtained, and yet today this charge has been improved by better than 50 percent. Certain shortcomings of the service were also determined at that time. It was known that the remnants of the steel liner which were not converted into jet material formed a "slug" or "carrot" that trailed along behind the jet stream plugging many of the holes produced. The cardboard tube, which positioned the charge opposite its port, escaped from the carrier and became an objectionable material left in the well. The other objection was the debris from the port fluid seal which fell to the bottom of the well. The elimination of these three objections outlined the goal which was to produce a clean hole into the formation and to leave nothing in the well.

First Improvement

The first improvement came in the form of a redesigned charge. The major changes were in the liner. This liner was changed from steel to copper, and the included angle was changed from 45 to 60 degrees. These charges penetrated approximately 4.9 inches in steel (Figure 4) with a uniformly round hole. The sharp increase in penetration is worthy of note. The "slug," which was still with us and will always be with us, consisted of a soft material which, for the most part, eroded because of the scouring action as it passed through the perforation. This charge, with refinements which enabled the penetration to be pushed to 5½ inches in steel in static tests, is the charge in service today.

A new charge is being field tested by the service companies. This charge produces a larger hole in the casing (Figure 5), has equal penetration, and represents a 20 percent increase in efficiency. This new charge is shown in the static test

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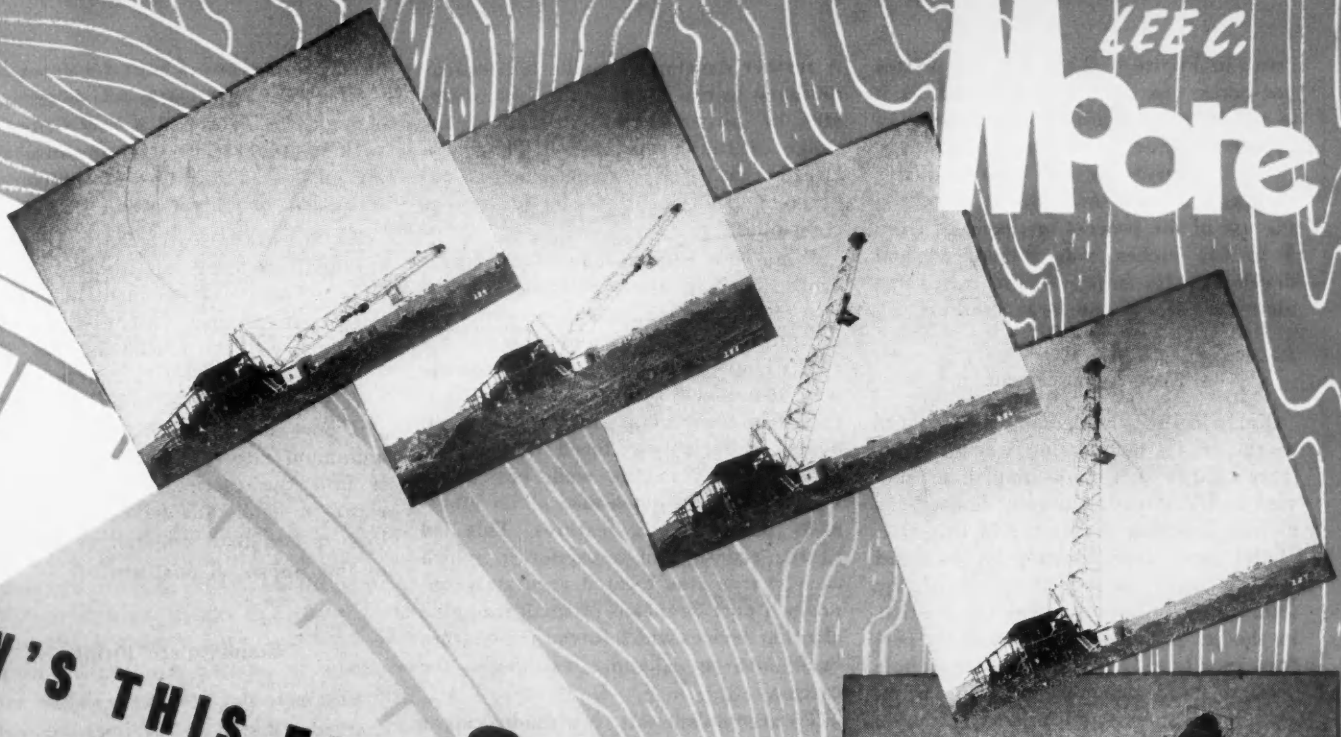

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setup in Figure 6. The progress of this one-ounce charge has been traced, as it is the oldest and most representative of the improvements in the jet process. Concurrent with the development of this charge, a smaller one, which permitted the use of the process in casing of from 5 to 6⅝ inches, was introduced and developed. Its improvement traces the identical path of the larger charge.

New Advancement

Early in 1949, the demand for a charge to run in 4½-inch casing was satisfied. This charge met with immediate success as there was an urgent demand for a deep shooting perforator in this size. Bullet guns were severely handicapped by the small outside diameter of the gun. This limitation, which also exists in the jet perforator, influences its performance to only a minor degree as hole size instead of penetration can be reduced to compensate for the reduction in charge load.

To project the charge development into the future, the two smaller charges will, of course, follow the pattern of the one-ounce charge and be redesigned. The new charges, no doubt, will produce a larger hole with increased efficiency. A further development will be a charge designed to run in 2½-inch inside diameter or larger tubing to extend the range of the jet process. This charge already has been designed and is undergoing laboratory tests by the service companies.

While the charge manufacturer was proceeding with the development of the charge, the service companies were concentrating on improving the carrier design. The cardboard charge container was abandoned by some service companies in favor of a phenolic container, which appreciably reduced the amount of debris left in the well, but which was later rejected because of its inherently poor aligning features. This led to the redesign of a carrier in which each charge was located accurately opposite a port by means of small frangible aligning devices which forced the charges back into an aligning recess in the carrier.

To accomplish this, two main designs for port seals were developed. In one, a large brass seal was used and in the other, a steel screw port assembly. This assembly normally left only a small brass ring from the port seal in the well. After a short period of use an objectionable feature became known. On occasions the entire port blew out, and if the running clearances were small enough, there existed a real danger of sticking the carriers with resulting fishing jobs. This objection soon forced the retirement of this type of carrier.

An intense research on port design resulted and several interim designs were adopted. Development in this field is still progressing. The most promising solution was introduced late in 1949. It was a retainable aluminum screw port (Figure 7). The interior shape of this port acts as a wedge, forcing the aluminum into the threads and locking it into the carrier. Several thousand shots in field runs have resulted in a loss of less than one-half of 1 percent of this improved port seal.

Standardized Firing

Possibly the greatest single factor that contributed to the improvement of the jet perforator was the development of a standard method of test firing. In the early stages it was known that shots could not be fired closer than four shots per foot because of sympathetic detonation between adjacent charges. The effect, if any, of this spacing of the charges on their performance was not known. Under certain conditions the loss of penetration was severe, and it became necessary for the service companies to test exhaustively the charges under their conditions of firing. It was important that a goal be established on which to evaluate performance. The static block test already illustrated was the basis. The performance of the charge when not influenced by port seal, aligning parts, carrier and adjacent charges, was determined. Then each part was added singly, and its effect on performance determined. If it influenced the performance, steps were taken to correct the part. This step-wise procedure was continued until a fully assembled carrier was fired in a test fixture, illustrated in Figure 8.

In all tests the steel used in the targets was mild, fully annealed, to produce maximum uniformity. The improvements realized are illustrated by comparing Figure 9 with Figure 10. Figure 9 shows the results in the early stages of testing the one-ounce charge. Notice the lack of uniformity and the irregularity of the holes. Figure 10 shows the results at the conclusion of the tests. The improved penetration and the uniformity of the results are apparent.

This same testing procedure was in turn applied to all size charges, and in

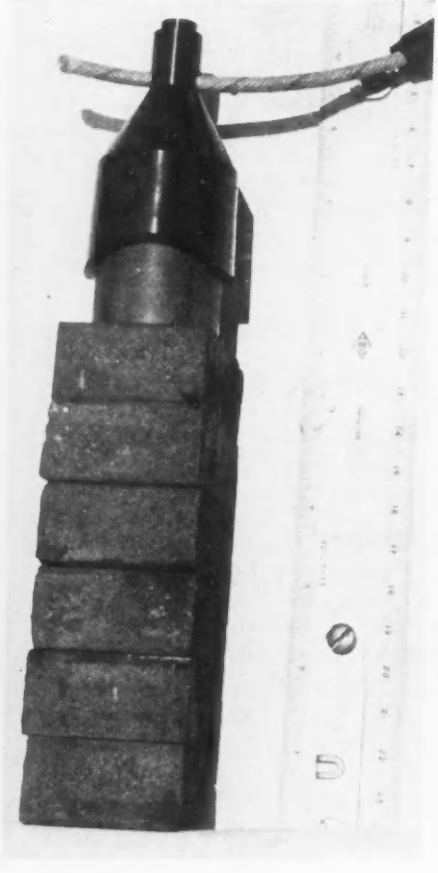


FIGURE 5 (left). Comparison in hole size between the new and old one-ounce charge.

FIGURE 6 (right). The new one-ounce charge in the static test setup.

each size marked improvements were realized. The accumulation of this data has proved a necessary tool in the analysis of newly designed charges. It is now considered sound engineering practice to test thoroughly each alteration that might occur in design to see that the maximum performance is being realized. This improved testing procedure is the operator's guarantee that he is receiving the maximum in performance. These proven engineering practices are being followed in another application of the jet process — open-hole shooting.

Open-Hole Shooting

Open-hole shooting was first offered to the well operators on a commercial basis in August, 1948, in the Rocky Mountain area. Since that date more than 60,000 charges have been fired. The sustained demand, because of increased production and productivity, safety in use, and the ability of selectively shooting zones, has intensified the research and development of this new tool.

In open-hole shooting an air chamber or steel tube is not employed to confine and absorb the shock of the explosion. The unrestricted impact of the shock wave on the formation is desirable. The carriers for the charges, and the charges themselves, were designed to meet this requirement. These charges differ considerably in size and shape from the jet perforators, yet the five basic component parts previously mentioned remain intact (Figure 1). The most pronounced difference, aside from the increase in the weight of the explosive load, is that the open-hole charge must be a pressure resistant and fluid tight unit.

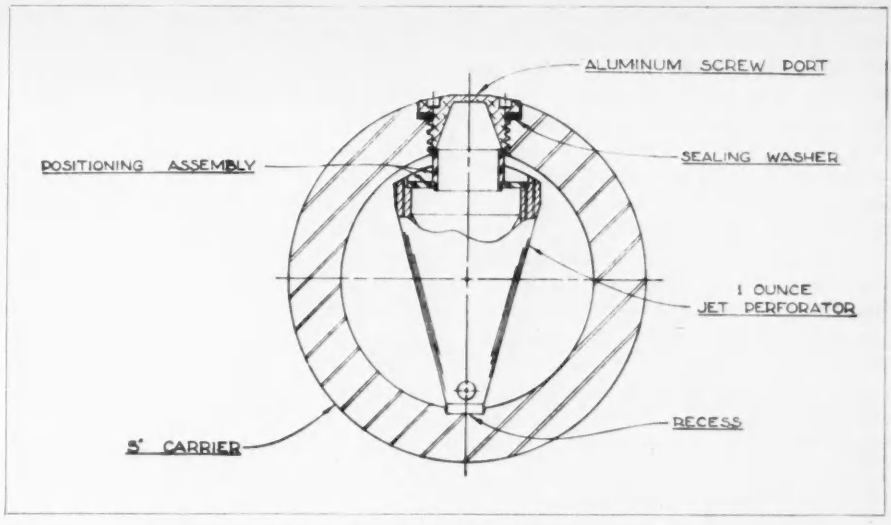


FIGURE 7. Cut-away drawing of the retainable aluminum screw port currently in use.

The two types of charges which have been in use during the past year have glass liners made of two 60-degree glass cones whose bases are fused together. One charge has an explosive load of five ounces. The other has an explosive load of two ounces. The carriers are fabricated of thin sheet aluminum and serve to hold the charges in place adjacent to the detonating cord, and carry the charges to the shooting zone.

Followup reports on the many jobs performed in the last year testify to the effectiveness of open-hole shooting in completions and workovers of wells. Acidizers report a greatly decreased break-down pressure when acidizing after shooting. Caliper surveys before and after shooting record a large increase in bore diameter, but, compared to the use of nitroglycerin, an appreciable reduction in clean out time is realized.

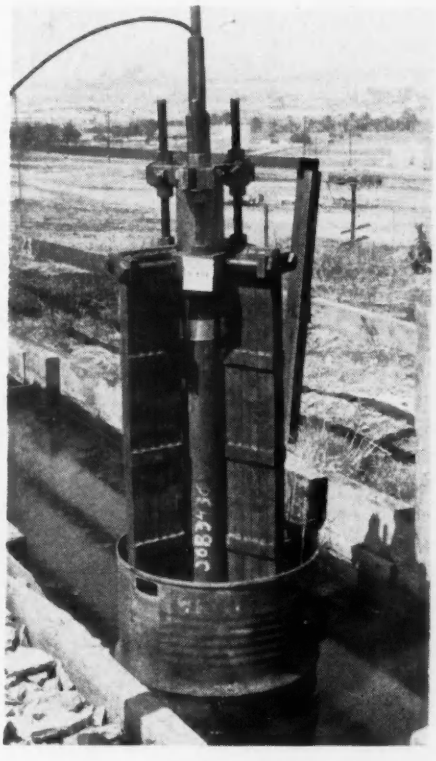
The most recent step forward is the incorporation of the efficient copper cone liner in a pressure resistant and fluid tight case (Figure 11). The static test method, using this charge, yields penetrations in mild steel blocks up to six inches deep and entrance holes of one inch in diameter. These results are shown in Figure 12.

Increase in Penetration

The basic improvement in this charge is a sharp increase in penetration. It is the goal of the service companies to produce a similar charge, but with the liner and explosive incorporated in a cartridge which may be inserted into any pressure resistant case. This relieves the charge manufacturer of the consideration of well pressures, and the charge can be designed for maximum efficiency.

The future possibilities of this phase, both in open-hole shooting and as a super-perforator beyond man-made barriers, appear promising. Its ultimate place as a tool in the industry is not yet established.

In reviewing the progress of the jet perforator, it is important to list the



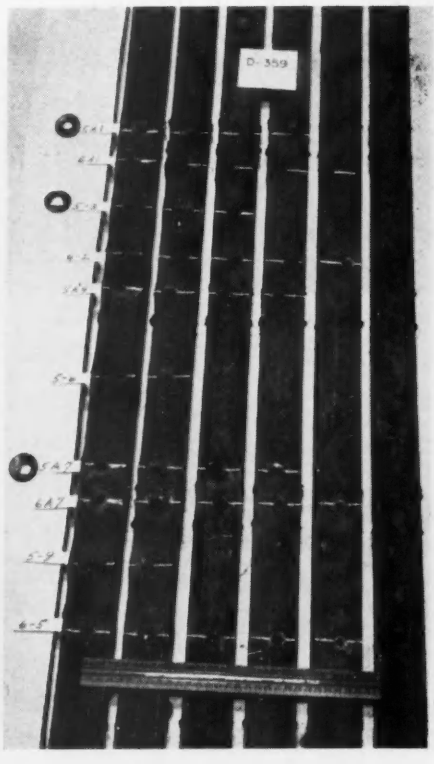


FIGURE 8 (Left). Test fixture for firing fully assembled carriers. Target bars are clamped to outside of carrier. Fixture is submerged for firing.
FIGURE 9 (Right). Performance in one-inch target bars made in early tests. Bars have been laid flat in order to show holes made by each charge.

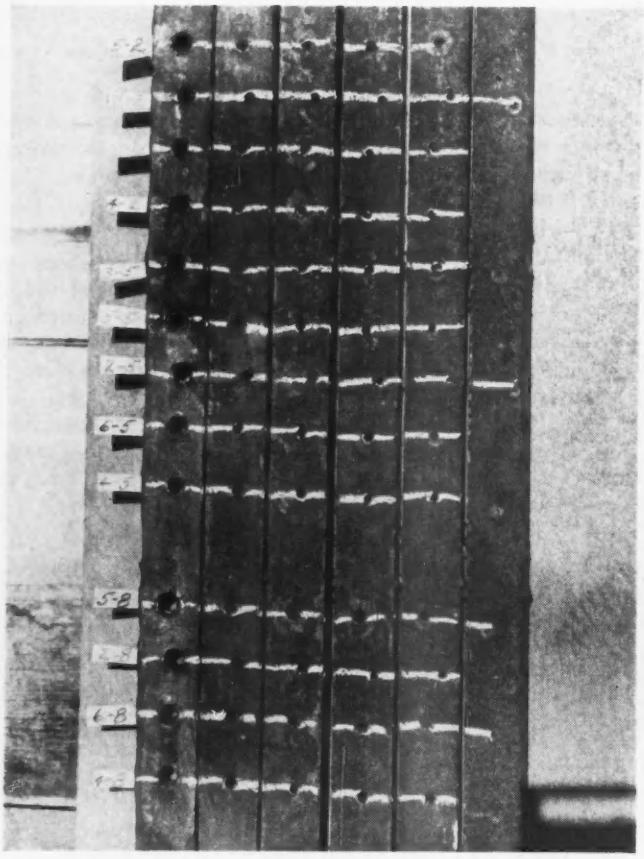
outstanding feats that have occurred in the last two years. The world's deepest well was perforated below 18,000 feet with jet. The world's deepest producer, below 15,000 feet, was completed with the jet perforator. One hundred shots at a time were fired in this well at 25-foot intervals. Semi-selective firing, which permitted shooting more than one interval on a single run, was successfully introduced. Jet perforating in combination shooting and testing was introduced, and 168 shots were fired below a tester on a single round trip on drill pipe. It is, of course, impossible to list the many successful accomplishments that have aided in the discovery of new fields and the increasing of oil fields' potential.

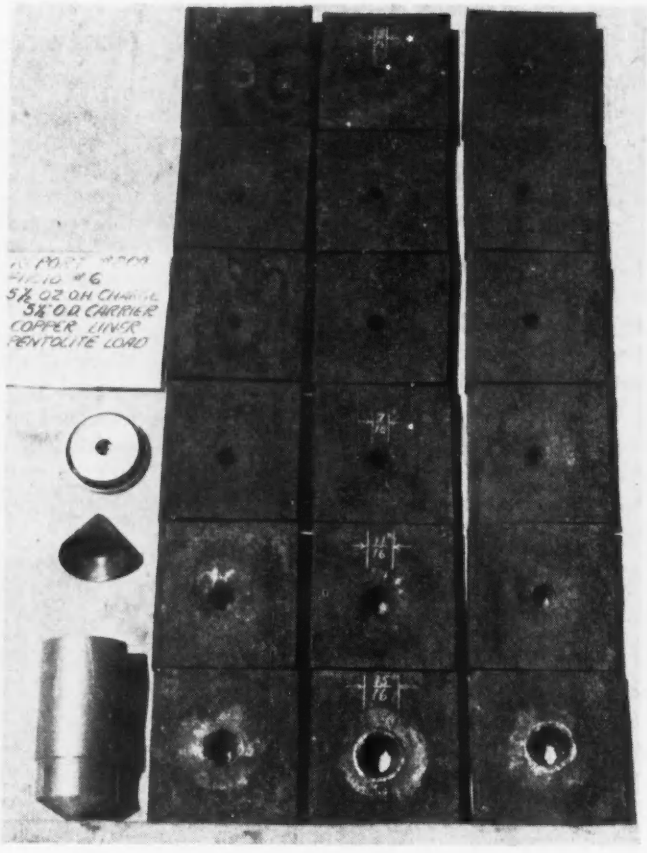
Much still remains to be accomplished in the advancement of the jet perforator. However, developments should occur more slowly and systematically, as this phase of the process has now come of age. Developments will occur to increase the flexibility of the jet, particularly along the lines of hole size in casing. The efforts will be to fit the process more closely to the needs of the operator.

The jet perforator is established in the tough perforating job. It is in the field of easy jobs, where both the jet and bullet penetrate into the formation, that much is to be learned. Whether the jet will replace bullet perforating entirely or supplement it has not been answered and will not be answered until the jet has been fully exploited.

In conclusion, it must be said that the progress outlined in this paper is due, in no small way, to the cooperation of the oil industry for its assistance and understanding in overcoming the inevitable growing pains.

EDITOR'S NOTE: This paper was presented at the Los Angeles Basin Chapter meeting of the API, January 17, 1950, by Robert T. Harcus, vice president and general manager of International Cementers, Inc. Those interested in the theoretical aspects of shaped charges or jet perforators are referred by the authors to the article, "Explosives with Lined Cavities," *Journal of Applied Physics*, June, 1948.





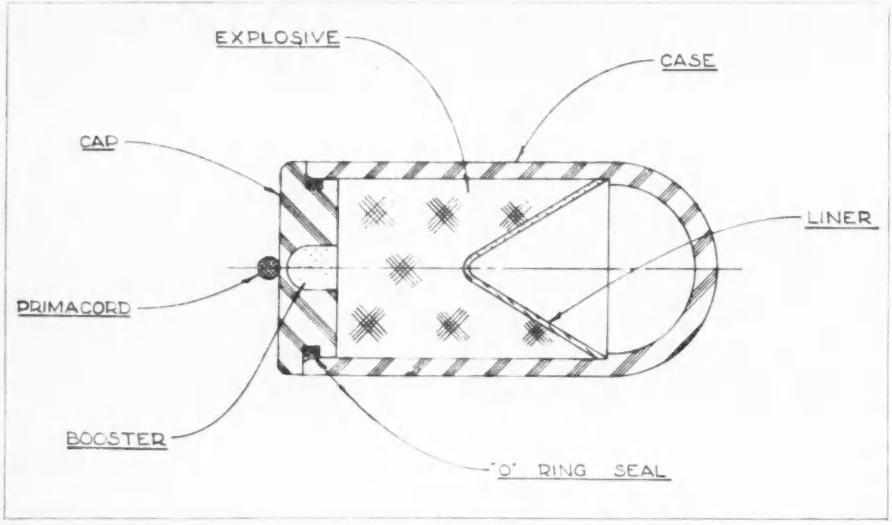
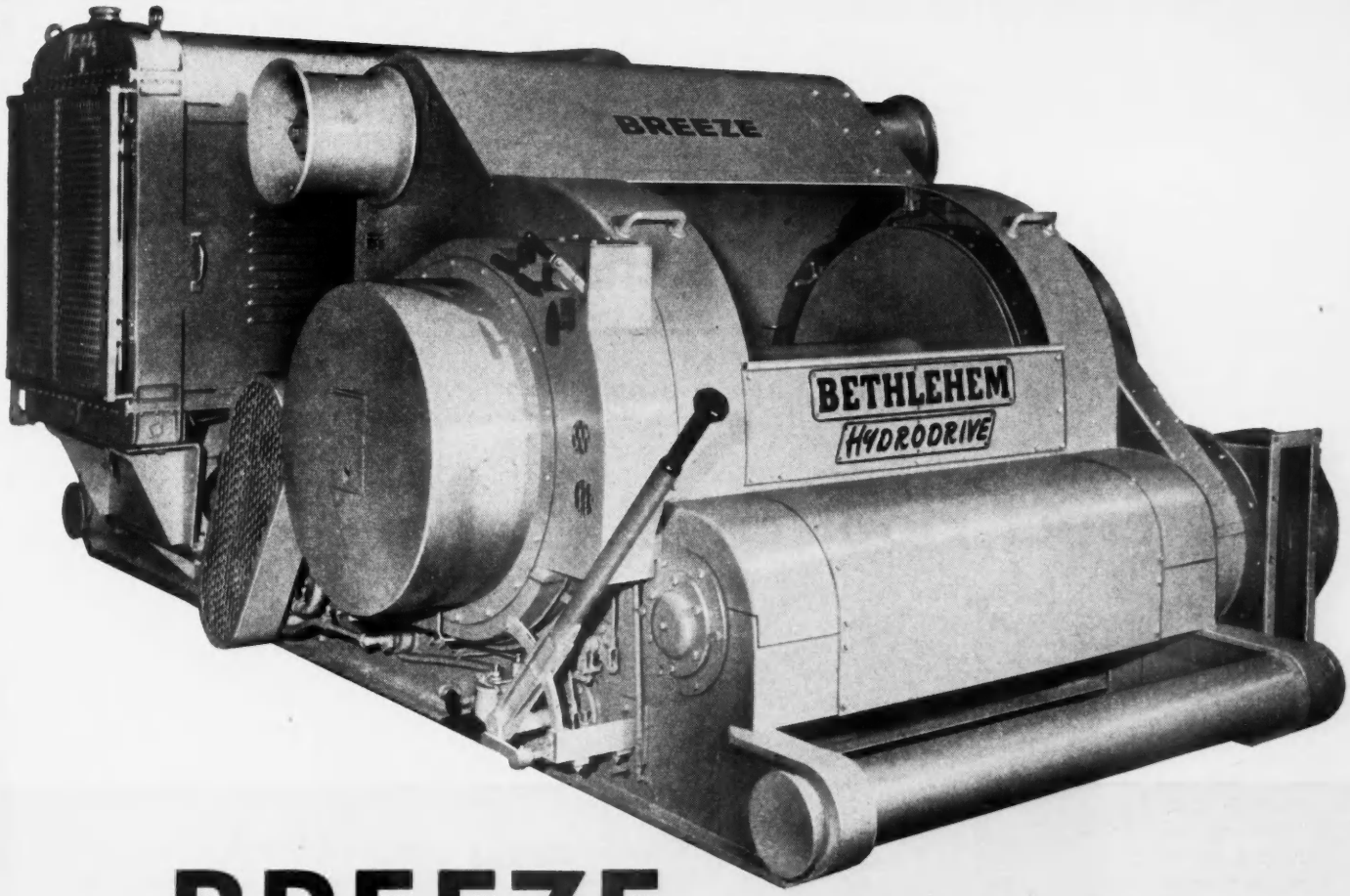


FIGURE 10 (top left). Performance in one-inch target bars, final tests.

FIGURE 11 (lower left). New type open-hole charge contained in pressure-resistant and fluid-tight case.

FIGURE 12 (top right). Penetration in one-inch thick blocks made with new open hole charge.



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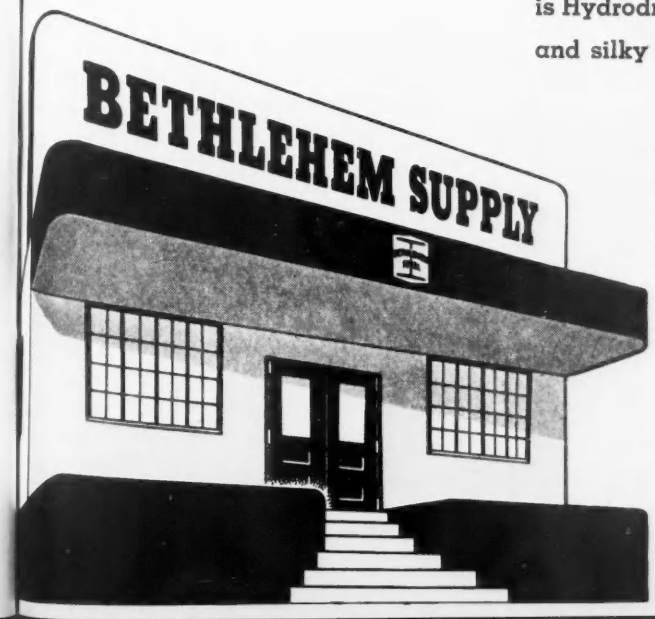

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HOW TO—Erect Floor Level Loading Ramp

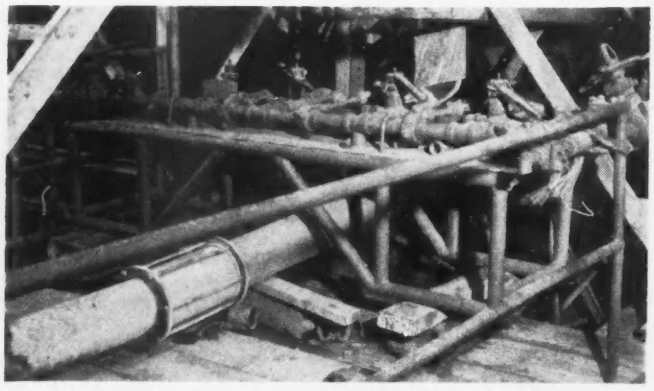
When three blowout preventers are used, or a below-floor steam engine rotary drive is employed, the derrick floor is so high off the ground level that the loading and unloading of heavy equipment becomes a real problem. This is particularly true in the case of loading the 16x16-inch steam engine and heavy-duty drawworks

The ramp illustrated solved the loading problem associated with high derrick floors, and has become a permanent part of the drilling rig. Top of the ramp is only 48 inches from the derrick floor, thereby placing average truck beds at the floor level when the truck is backed up to the ramp. The ramp is also useful to service companies who must load and unload equipment on the rig floor. Small trucks or passenger cars can easily be backed up on the ramp and small objects hoisted from the vehicles onto the floor.

The ramp is constructed of salvaged drill pipe and is welded throughout. It is in three separate pieces; the front wedge, the rear wedge, and the rear wedge platform. Each part is heavily braced to withstand tremendous loads. The top surface is covered with heavy steel plate to which is welded a continuous strip of expanded metal which provides the necessary traction for truck tires.

The front and rear wedges have the same slope and form an angle of about 20 degrees with the ground level. The rear wedge platform is a rectangular-shaped framework which elevates the rear wedge section to its proper height. Heavy steel plate wings welded to the outside edges of the platform hold the rear wedge section in alignment with the front wedge. When moving the ramp, the rear section folds over on top of the front section and the platform is placed on top to form a box-like load.

HOW TO—Install Blowout Preventer Control



The assembly of four-way valves which control hydraulically-operated blowout preventers has been unitized on most rigs so that a member of the crew may quickly close and open the preventers in an emergency. Most of the installations are made on the edge of the derrick floor where they can be reached without lost time. However, considering that the rig floor is already filled to a maximum with other essential equipment, and that very little is lost in descending one flight of stairs, this blowout preventer control unit may well be placed on an intermediate deck about ten feet below the derrick floor.

It is similar to many blowout preventer control hookups in principle, but different in that the man operating the controls is in position to observe the closing of the rams by watching the ram stems travel in or out. While all control valves are clearly labeled, the operator can instantly determine if a preventer is closing even though the valve is turned to the closed position.

The complete control assembly is mounted on a pipe skid framework which straddles the mud return line. Its height is such that the operator doesn't have to bend over or reach for a valve when he operates the controls. The valves and piping are bolted to the skid and provide a means of moving the assembly without breaking out the various pieces.

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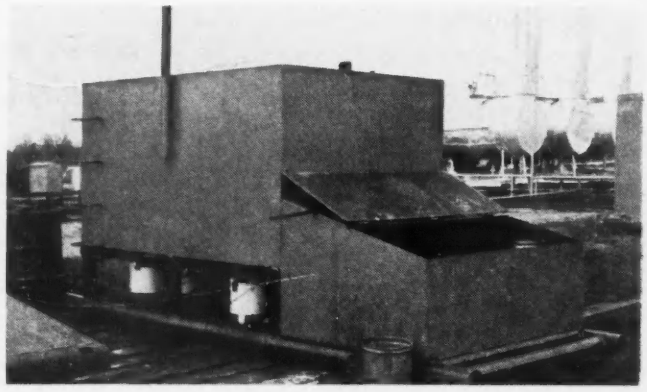
HOW TO—Store Lubricants at Rig



Ready availability and ease of handling lubricants around the drilling rig are encouraging to their regular use. Illustrated is a unitized lubricant skid containing three grades of lubricating oils (or two oils and one solvent) and a grease cabinet. Buckets of various grades of grease can be stored in the compartment in the foreground showing the cover opened. Sufficient storage space is provided to accommodate at least a dozen 25-pound cans plus rags and hand grease guns. Additional grease storage during drilling of the well is provided on a protected rack below the lubricating oil compartments at the left end of the unit. Here, partially used cans are stored so they are easily identified.

Made of welded steel plate, and mounted on a pipe skid, the three main compartments are elevated about 20 inches to facilitate filling oil cans of various sizes. These compartments are filled through the top where filling openings are located. Drums of lubricating oils are hoisted to the top by a chain hoist supported by an inverted ell post, the bottom of which is shown. The vertical post is made of 2½-inch pipe that fits into short section of three-inch pipe welded to the storage compartments and sealed at the bottom.

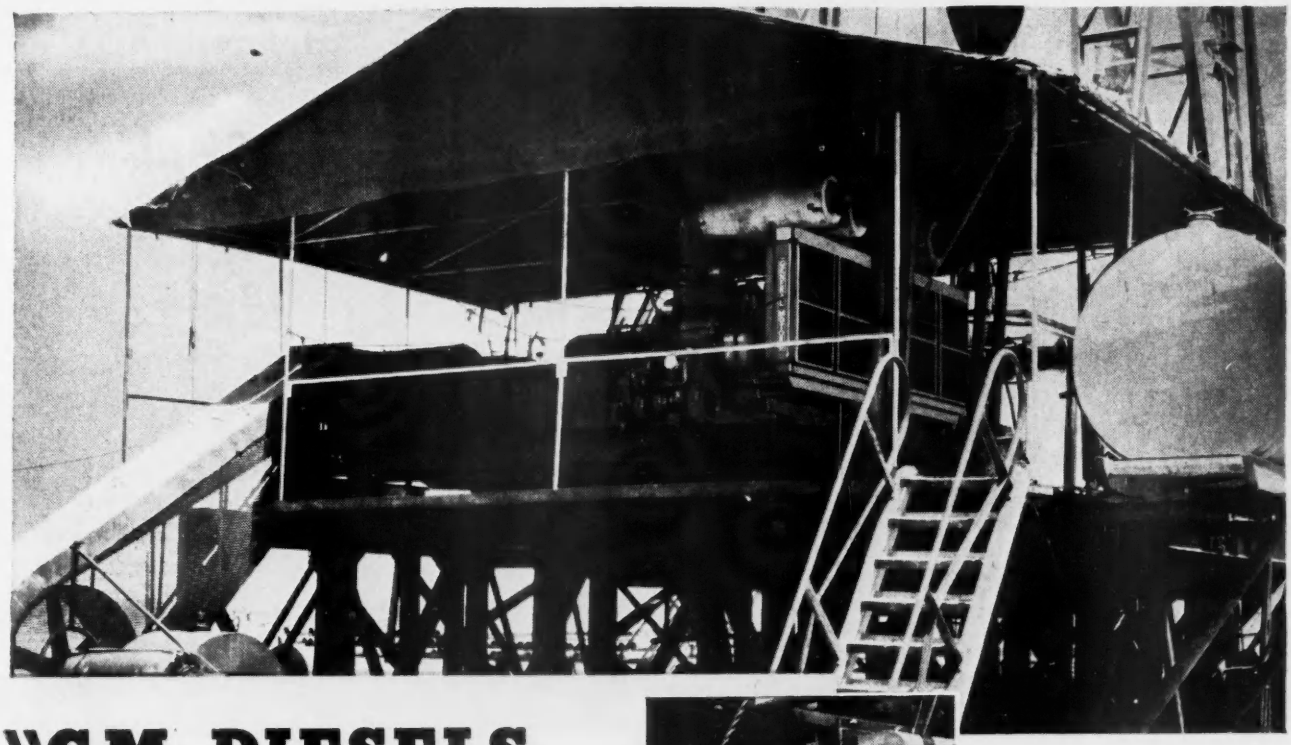
The entire unit is placed as near the derrick floor as possible so that lubricants are made available at all times and in quantities required for a complete lubrication.

HOW TO—Improve Shale Jet Unit

On deep wells, a considerable volume of material is removed from the hole. Most of this material comes out of the well in the form of cuttings and is separated on the shale shaker. Usually, these cuttings pile up in a small pit excavated below the screen overflow to pick up the cuttings and carry them to the shale pit. Unless the jet is moved about, it will pick up only those cuttings in the vicinity of the jet.

This improved system insures that all the cuttings coming off the shale shaker screen will be carried away from the rig without permitting them to pile up at the shaker. The principle utilized in the mud mixing hopper is used here. The shale shaker assembly has been elevated on a pipe framework, and the cuttings discharge into a large hopper, which is an inverted pyramid of sheet steel.

As shale cuttings flow over the shaker screen and into the hopper, they are directed to the intake of the shale jet which is attached to the apex of the pyramid hopper. When sufficient cuttings have accumulated in the hopper, the derrickman can easily open the jet valve at the shale shakers to discharge the load of cuttings into the shale pit.



"GM DIESELS *give us faster round trips"*

says James G. Cullum of Wichita Falls, Texas

Wilson Giant rig, operated by Cullum Brothers Drilling Co., is powered by two GM Series 71 Diesel Twin sixes delivering 276 continuous H.P. per twin at 1000 RPM shaft speed. Table speed up to 180 RPM. Gardner-Denver 7¾ x 16 mud pump, V-belt driven from chain compound, delivers 650 to 700 lbs. pressure with 7¼" liners, 63 strokes per minute.

THE sizzling pace young Jim and Landon Cullum are setting for speedy completions in the North Texas fields has won them the reputation of "fastest drillers in the area."

Records like this tell the story: 70,000 feet of hole drilled in the first 8 months—4,000 feet in 4 days and 9 hours, using 13 bits—and, on a speed test, 1,450 feet with one bit in 9 hours. What do you find powering Cullum Brothers' rig? General Motors Series 71 Diesel engines.

These modern 2-cycle Diesels are compact as well as powerful. They're lower in weight as well as husky. They pick up under load fast and they stay on the job.

Oil men everywhere are finding that GM "71" Diesels make drilling faster, easier and much more profitable. It's sure worth looking into. Let us see that you get the full details.

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SINGLE ENGINES... *Up to 200 H.P.* **DETROIT 28, MICHIGAN** MULTIPLE UNITS... *Up to 800 H.P.*

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GM GENERAL MOTORS DIESEL POWER

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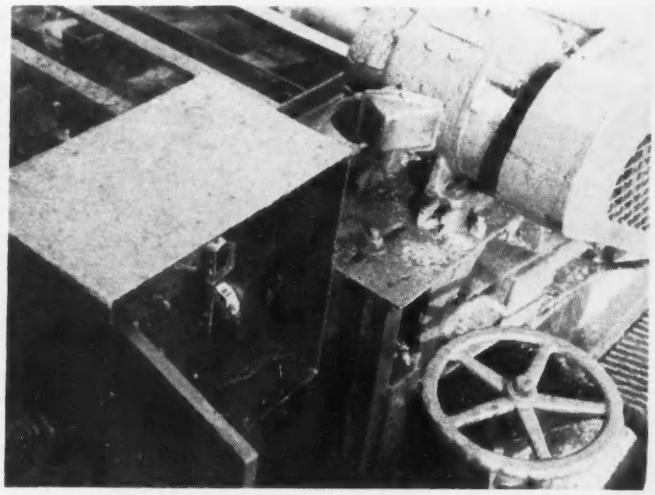
HOW TO—Regulate Shale Shaker



Electrically-driven shale shakers are usually run at the speed of the driving motor unless a speed controller is used. During normal drilling operations when the pumps are operating at normal speed, and the flow of fluid across the shaker screen is such that no liquid mud goes over into the shale pit, the shale shaker can be operated at the speed of the driving motor. However, there are times when a smaller volume of mud passes over the shaker screen and the unit can be operated at slower speeds, thereby effecting less wear and tear on the shaker and motor. Going in the hole with drill pipe is such an occasion when relatively small volumes of fluid go over the shaker screen.

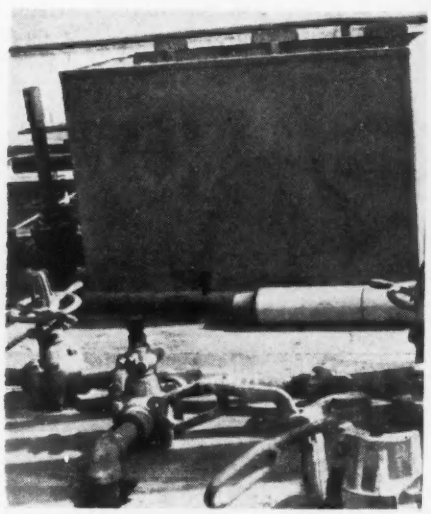
The installation of a starting switch and rheostat speed control enclosed in a metal box make it possible to regulate the speed of this direct-current motor from zero to full rated speed. When going in the hole, or when circulating slowly, the derrickman can adjust the rheostat to slow the shale shaker.

HOW TO—Measure Fluid in Well

This metal box may be mistaken for a tool box by someone not familiar with its use, but to those who know its application, this measuring tank is far more valuable in the information it reveals. When making a round trip, it will reveal whether or not the hole is taking fluid, or blowing it out the return line. The tank is a measuring vessel carefully designed and gauged in several ways. Steel rod cross pieces welded to vertical rods measure the volume of fluid in barrels; a second such device is calibrated in wet stands of both 4½-inch drill pipe and 2⅞-inch pipe; while a third gauge stick is calibrated in dry stands of both drill pipe sizes.

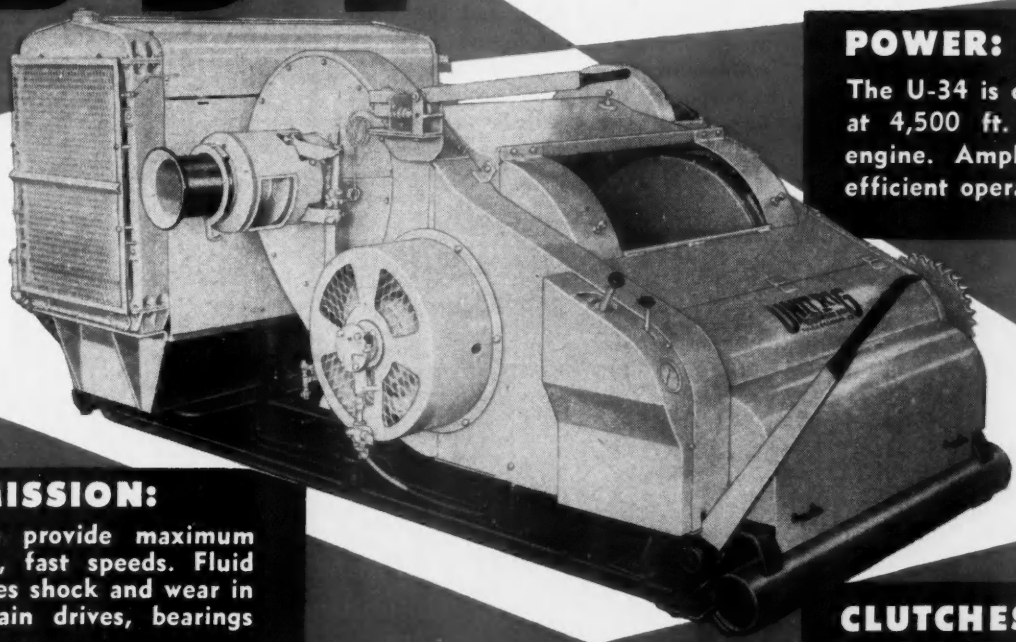
The measuring tank is connected to the mud fill-up line through the valves shown on the derrick floor at left of the tank. Both discharge and mud supply lines are connected into the tank, the supply line being connected to the standpipe through the valves shown in the foreground.

When coming out of the hole, the tank is completely filled to the upper gauge mark. The stands are counted, and after several have been pulled, the volume of mud displaced represented by the volume of the drill pipe, whether the stands are pulled wet or dry, is permitted to flow by gravity back into the well. If this volume of mud does not bring the fluid level in the hole back up to its previous level, the indications are that the hole is taking mud.



U-34

CUT COSTS on shallow well drilling. . .



POWER:
The U-34 is conservatively rated at 4,500 ft. with a 275 H.P. engine. Ample power for fast, efficient operation and long life.

TRANSMISSION:
Designed to provide maximum pull at safe, fast speeds. Fluid coupling saves shock and wear in clutches, chain drives, bearings and line.

CLUTCHES:
UNIT RIG'S Air-O-Matic . . . time-tested under all conceivable conditions. Eliminates adjustments. Same type used on rigs of much greater capacity.

Smooth, fast, trouble-free performances are the keys to drilling in any well at minimum cost. All these features were taken into consideration when the U-34 was designed. That's why this popular, compact UNIT RIG model is being used more than ever before for shallow well drilling and servicing.

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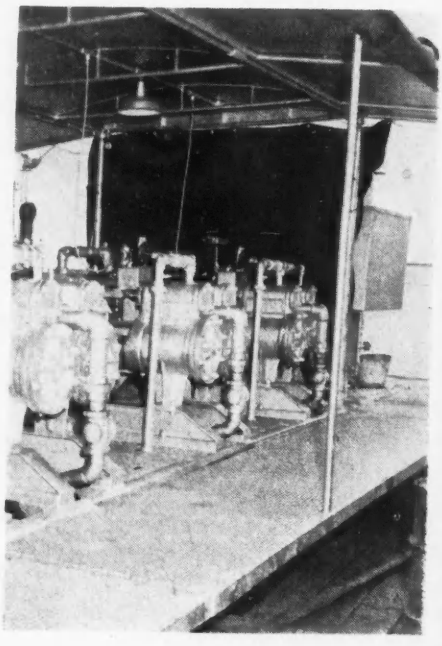
HOW TO—Attach Roof on Boiler Feed Water Unit

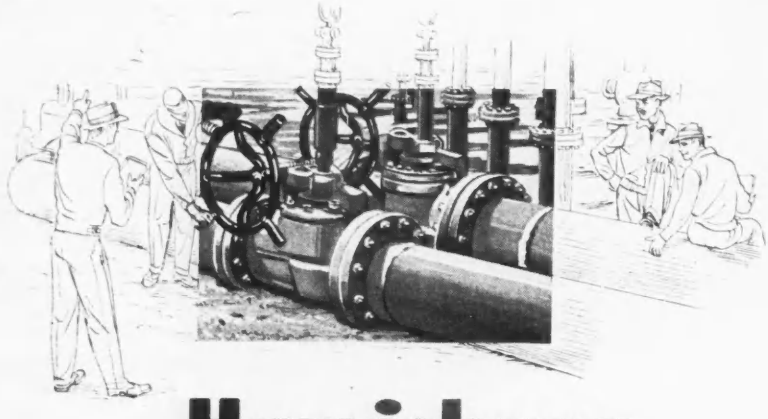
There are several features about this boiler feed water unit that are unique, but perhaps the most unusual one is the manner in which the roof is attached to the vertical uprights. The joint between the upper section forming the roof and the four legs is actually a ball and socket joint. It will permit movement between the respective members, and therefore, the rigidity of the roof depends upon the stiffness of the four corner posts.

Purpose of the ball and socket joints is to permit the roof to be lowered several feet during a rig move without binding at the corners where the legs or posts telescope into one another. If the corners were a stiff, solid joint, the entire roof would have to be lowered evenly all around to prevent binding, and ten or twelve men would be required to do this job. However, with the ball and socket joint, four men can adjust one end easily, then proceed to adjust the opposite end.



Another helpful feature shown is the method of utilizing the side or closing pieces to form part of the floor and roof. During shipment, these extensions are folded vertically; the bottom section folded up, the top or roof section folded down. The roof is lowered until these sections meet to form a solid side wall, thus enclosing and protecting the boiler feed water and firing controls. These extension pieces are welded to pipe nipples which fit loosely around the horizontal pipe framework supporting the arched roof and the skid member. The floor extensions are braced from underneath, while the roof sections are supported by vertical pipe resting on the floor extensions.

A third convenient idea (and one appreciated in winter) is the enclosure effected by draping a heavy canvas curtain around four sides of the unit to exclude wind and rain. The canvas is wired to the roof extension through metal grommets in the cloth. The curtains are secured at all corners to provide a satisfactory enclosure.



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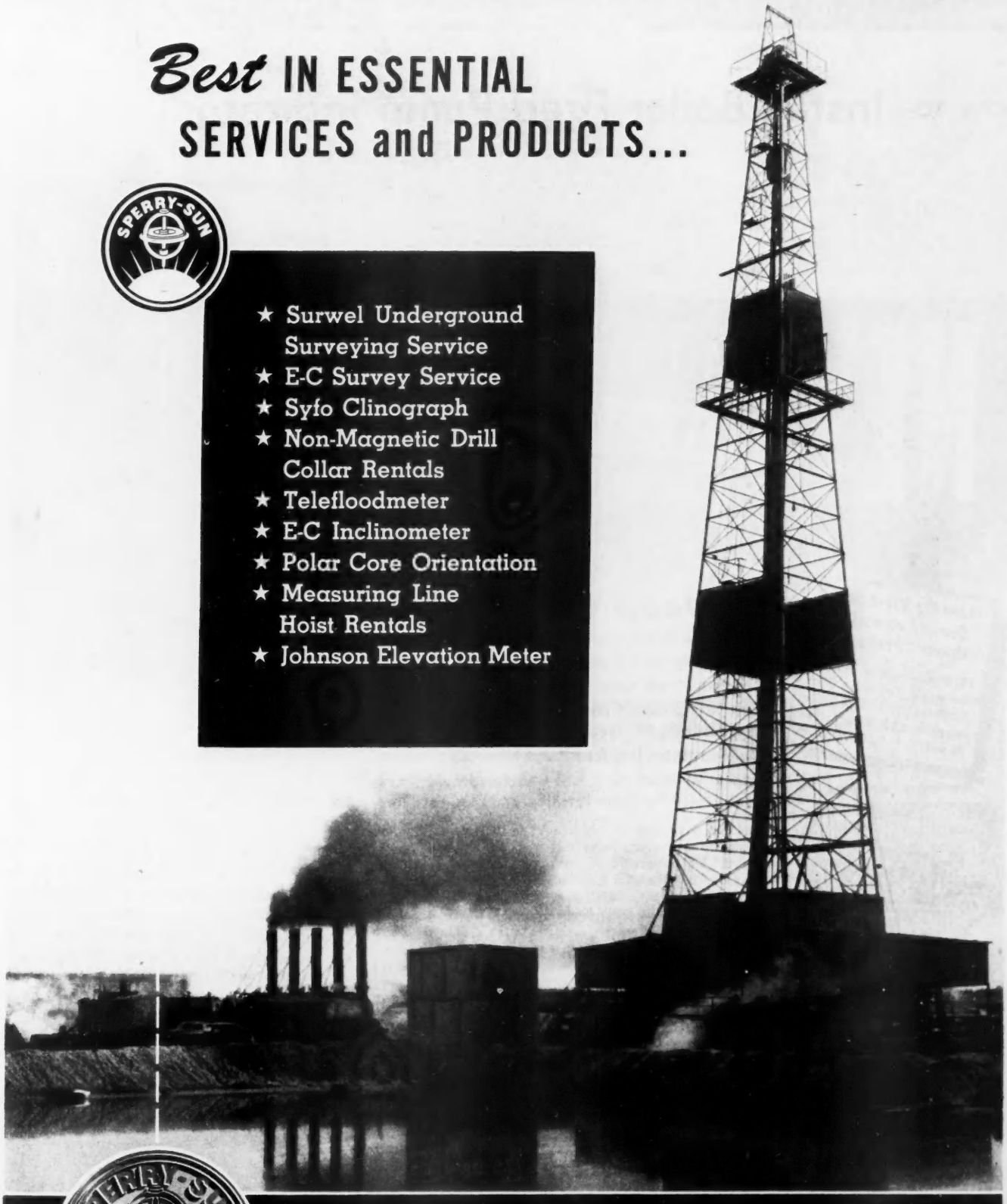
- ★ Measuring Line Hoist Rentals
- ★ Johnson Elevation Meter



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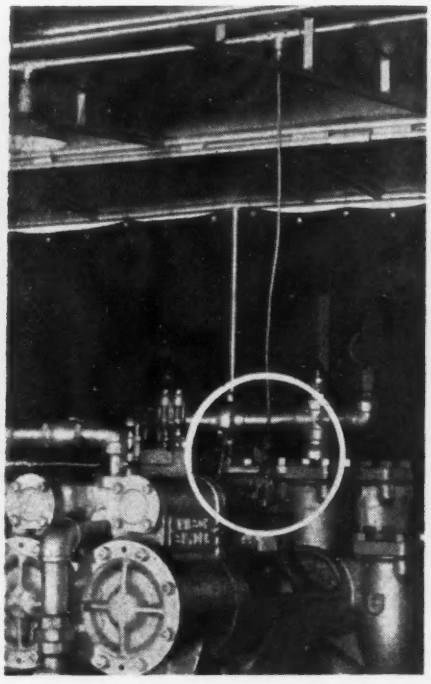
Lafayette, La. Bakersfield, Calif. Moulden Oil Field Services, Casper, Wyo. Crossville, Illinois

HOW TO—Install Boiler Feed Pump Indicator

During a trip out of the hole with drill pipe, important equipment that must not fail is the boiler feed water pump. It is usually customary for the fireman to help the crew when making such a trip, and during such operations, he is taken away from his post at the boiler battery. The fireman must know at a glance from the drilling rig floor whether his boiler feed pumps are functioning, but the indicator



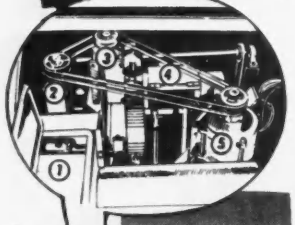
is so out of the way that it can barely be seen in the illustration.

Instead of the usual metal flag or stick attached to the rocker arm on the pump, this ingenious device utilizes a mercury switch mounted to the rocker arm bearing housing. The mercury bulb contains two electrical contacts which, when both are immersed in the mercury, make a completed circuit. As a rocker arm swings back and forth, the mercury alternately makes and breaks contact with these two electrodes, thereby acting as an on-and-off switch synchronized with the rocker arm motion.

The circuit connected to the mercury switch includes a red electric bulb mounted on the derrick side and to the outer wall of the enclosed boiler feed water unit. As the rocker arm reciprocates, causing the mercury to make and break contact in the circuit, the red light outside the housing turns on and off to signify to the fireman on the derrick floor that the pump is functioning. Such a circuit is installed for each pump; a separate red light for each pump. So long as all lights are blinking, the fireman knows that all pumps are operating. This simple method has many advantages over the old visual method employing red flags that are difficult to see at night.

NEW ALL-ELECTRIC SHALE SEPARATOR and SAMPLE MACHINE

Close-Up View Below Shows Centralized Power "Package":
(1) By-Pass (2) Mud-Spray Pump (3) Reduction Gear for Drum Drive (4) Sample Machine (5) Explosive-Proof ¾ H.P. D-C Motor

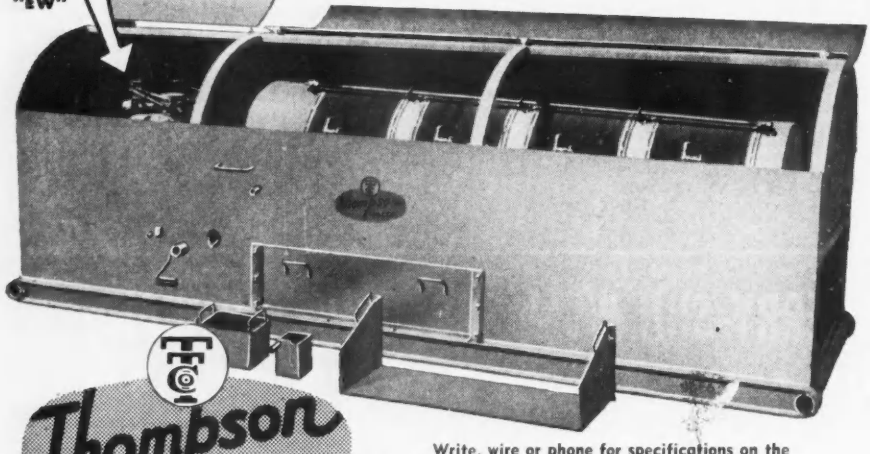


For Deep Well Drilling

- Increased cleaning range: handles muds at maximum pump discharge or deep-hole strings.
- Constant drum speed regardless of mud flow.
- Constant pressure mud-spray system . . . waterless cleaning of screens without altering mud.
- Built-in water jets for alternate screen cleaning.
- Explosive-proof ¾ H.P. D-C motor provides central power for drum rotation and mud-spraying.

Brand new to you but an "old buddy" to Thompson technicians who started months ago to put this precision machine "through the mill." Big pump mud discharge . . . mud strings . . . the Thompson "EW" handles it all in stride. Thompson separators have always done a good job of extracting the shale and abrasives that wear out drilling equipment. The new Thompson "EW" does that and more . . . it cleans the drill mud without altering it, by the new Thompson waterless pressure mud-spray screen cleaning system. Fully enclosed; skid mounted. Put the "EW" on your job!

MODEL "EW"



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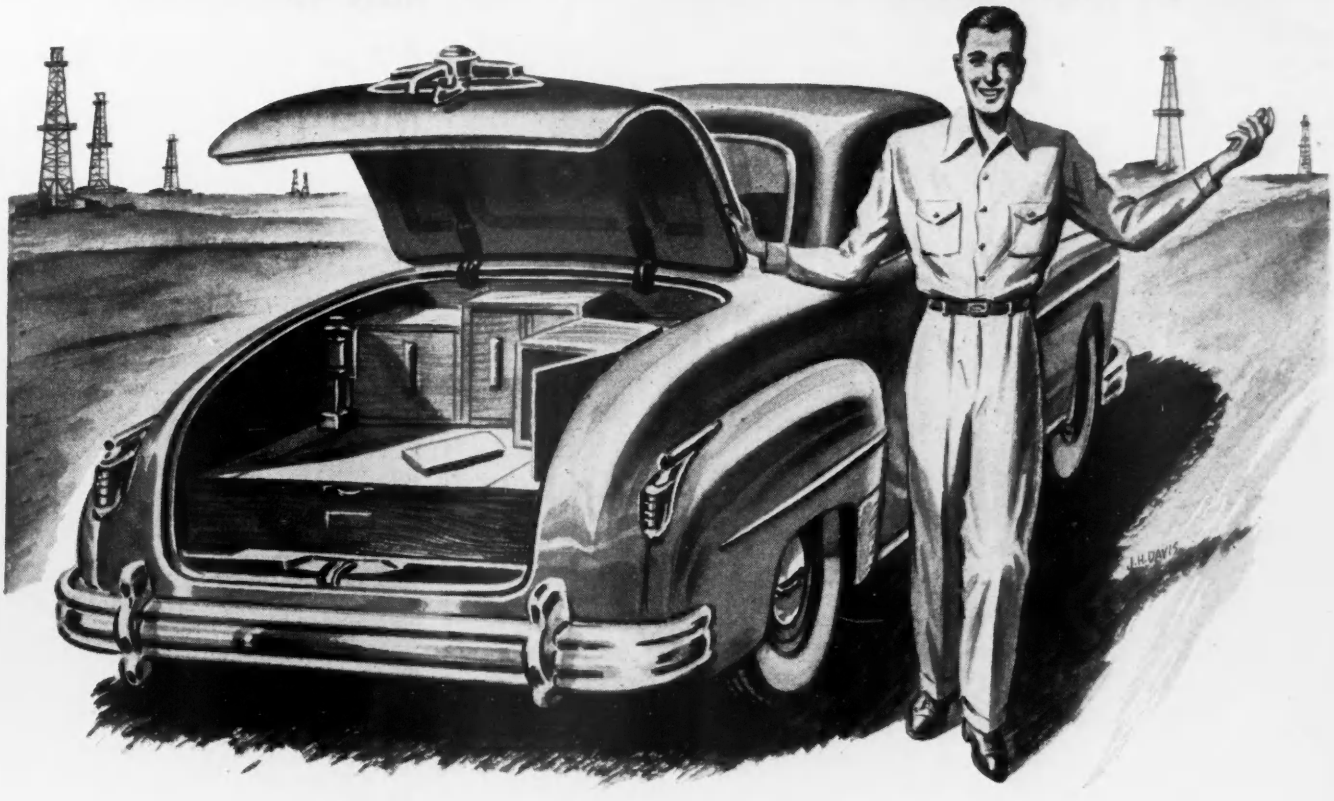

Are you puzzled by a mud that doesn't "act quite right?"
Do you want a complete, money-saving mud program outlined before you spud in?
Do you want immediate help with such serious troubles as blowouts, lost circulation?

Your Baroid service engineer has the answer to these and scores of other drilling mud problems. He knows muds and he knows drilling. He is trained and experienced in both (he may have worked on one of your wells before becoming a mud engineer). More than one operator has said that Baroid service men have freed many of their own engineers to attend to other duties.

When the Baroid engineer arrives, take a good look at the testing equipment cabinet built into the rear of his familiar blue coupe. Even the cabinet work is better than it was a year or more ago. The equipment has improved right along with the demands made upon it by more equipment. The Baroid engineer now can carry complete testing equipment units from his car, boat or plane, to the rig or shelter or wherever best to make his tests. This means faster, more accurate mud tests on your well. Baroid's service standards are the highest in the industry. With the Baroid service man's know-how and fine equipment working together, you can be sure of his answers.

Whatever Your Mud Problem . . .

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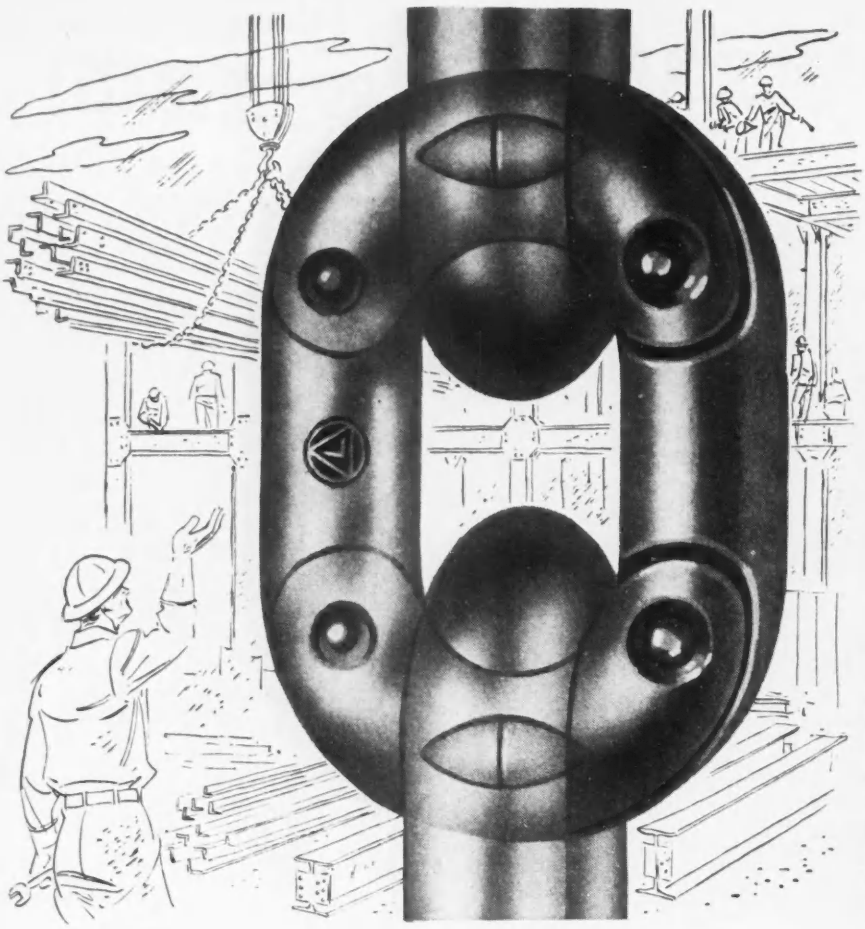

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Replace worn or broken links in any proof coil chain with Laughlin "Missing Links" — and your chain is stronger than it ever was before! That's because the perfectly matched halves put the load on the interlocking lugs with no strain on the rivets. You get this *extra* security at worthwhile savings in time and money, too, because "Missing Links" go on in a jiffy, much quicker and cheaper than welding. Made of drop-forged, heat-treated steel, super-strong "Missing Links" are available in all sizes from 3/16" to 1⅞" at your distributor's. Write for Laughlin Catalog #145, industry's data book of fittings . . . THE THOMAS LAUGHLIN COMPANY, DEPT. 23, PORTLAND 6, MAINE.

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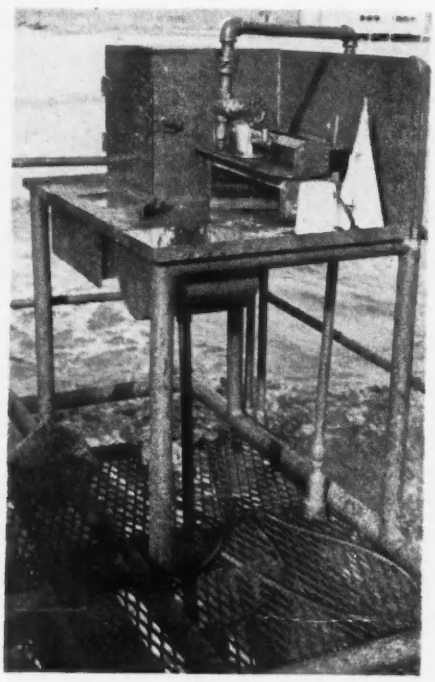
HOW TO—
Build Convenient Mud Testing Bench



As rugged as a mud testing apparatus may be, chances for it to be broken, damaged and lost during rig moves are good so long as it remains in service on the drilling rig. However, steps can be taken to avoid or minimize loss or damage to this equipment.

A convenient mud testing bench located near the shale shaker facilitates making the various tests on drilling fluid, and provides protective storage for the equipment when it is not in use or when the unit is being transported. The testing bench shown is a field version of a kitchen sink and cabinet. It was mounted on a wide pipe skid which made it easy to handle during loading. Four legs and cross pieces are of 2½-inch pipe, while eight-inch sheet metal serves as bench covering and cabinet material.

A short section of large conductor pipe welded to a rectangular hole in the bench formed a convenient sink in which to wash the testing apparatus. Water piping was not connected to the bench, but extended over the splash board and terminated just above the sink in a valve and nozzle.

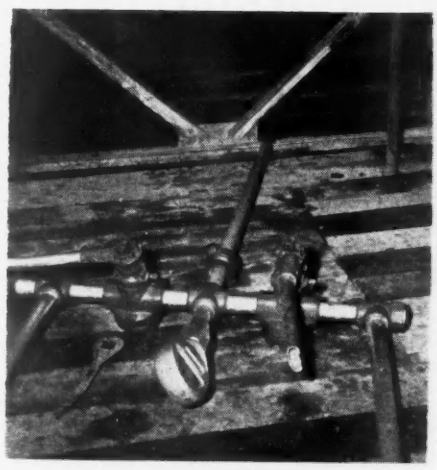
The mud balance, funnels and cups were stored with the filter press in the metal cabinet, which can be locked during shipment. A metal sliding drawer just below the cabinet handled extra

tools and supplies used in testing mud. The completed unit made the important task of testing drilling fluid more efficient.

HOW TO—
Bleed Off Casing Pressure from Well

When shallow gas pockets are encountered, it may be necessary to close the blowout preventers and the gate valve on the mud return line to prevent the drilling fluid from being blown out of the hole. In such cases, whether it be in shallow formations or in deeper zones, mud weight must be built up to overcome the formation pressure in order that drilling may be continued.

The piping and fittings shown are connected direct to the casing below the blowout preventers so that pressure accumulating in the annulus between casing and drill pipe can be controlled with safety. All piping is hydraulic and includes a four-way fitting that splits the flow through two parallel lines that discharge into the mud pits. Each wing is equipped with a plug valve and a tee. The wing at left is full internal pipe size, while that at right is fitted with a choke in the ell to provide a positive choking



of the fluid in the event high pressures are encountered.

A mud pressure gauge fixed at the tee section indicates the pressure existing in the line to enable the operator to decide whether to choke the well down with the positive choke or permit it to flow through the open wing at left. By controlling excessive and dangerous pressures in this manner, mud can be circulated slowly with a heavier fluid to overcome the formation pressure. A union in the feed line to the casing makes breaking out the control head simple.

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GAS LIFT VALVES
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SCRAMBLED
PRESSURES

THE ONLY GAS LIFT VALVE WITH INSURED WELL ACTION

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Camcoizing . . . an exclusive Camco process which pre-forms the valve bellows with 5000 lbs. differential pressure . . . tests and conditions the bellows for positive well action. Camco manufactures a complete line of Gas Lift equipment. Get all the facts from your Camco Representative . . . or phone or write Camco, Inc., 1108 Scanlan Building, Houston.

Camco Gas Lift Valves have proved far superior to any other gas lift valve on the market today!

NOW TIME HAS PROVED THE SUPERIORITY OF THE CAMCO DESIGN

For more than two years, Camco Valves have been in the most demanding services in the fields . . . because we gladly took the toughest ones to prove the merits of the Camco design. When pulled because of the encroachment of too much salt water, these Camco Valves have consistently tested right on the money after 18, 19, and 24 months continuous service. You owe it to yourself to not buy any gas lift valve until you know the full story of the Camco design.

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Dependable performance, day after day on difficult jobs, produces reports like these from Simplex Hydraulic users. Engineered for faster, safer jacking, these jacks include such features as leakproof high pressure seals of Neoprene; non-sticking ball valves; smooth acting ram of SAE X1112 steel — plus many others. Eight models; capacities from 3 to 100 tons — all safety-tested to 50% over rated capacity.

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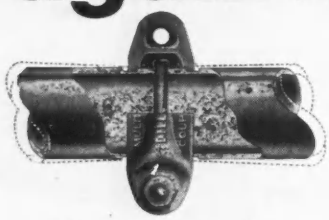

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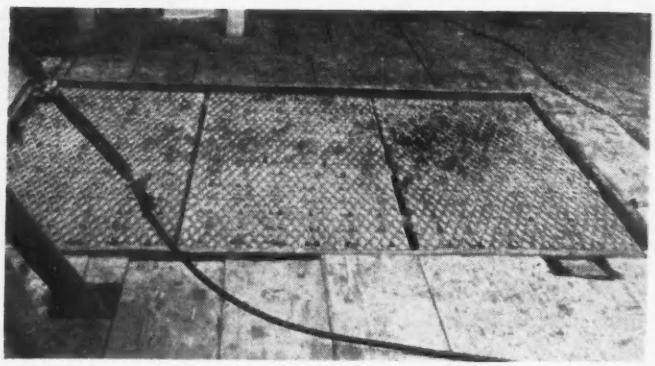
HOW TO—Hard Surface Pipe Rack



Stumbling hazards which arise when the drill pipe rack is elevated slightly above the floor level may be eliminated by several special but simple considerations in the construction of this hard-surfaced drill pipe rack. Substructure at this point was made of 8 x 10-inch sills and heavily braced below the floor.

A special heavy metal frame encloses the pipe rack and rests on the timber sills which are closely spaced below the rack. Top surface of the pipe rack, as shown, was made in three sections to facilitate handling. The sections which lay directly over the sills are made of heavy timber placed with the edges facing upward, and are securely joined together.

One of the important features of this rack is the hard surfacing which prevents the heavy drill pipe from cutting and fraying the wood surface. This hard surfacing is heavy gauge expanded metal nailed to the mats with steel staples. Grooves and troughs in the expanded metal provide excellent drainage of mud from the pipe, and provide for the pipe racker a good footing, even though the floor may be covered with mud. Surface of the pipe rack is slightly below the main floor level, but not enough to form a stumbling hazard.

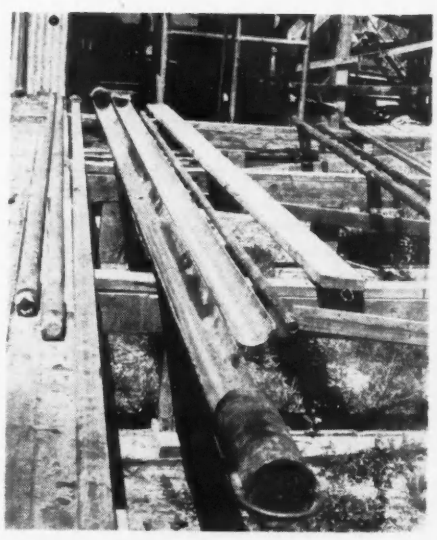
HOW TO—Make Pipe Laydown Unit

Laying down drill pipe at the completion of a well is a long and arduous task. Each joint must be disconnected and lowered down the V-ramp and placed on the drill pipe rack awaiting transfer to the next location. A simplified device makes laying down the drill pipe easier and offers protection to the pipe.

The apparatus illustrated might be termed a drill pipe chute, for it serves to guide and support the pipe from the derrick floor down to the catwalk where it is rolled onto the racks. The device is set aside here and is not in position for use. The two pieces shown comprise the necessary parts.

The half-sliced section of pipe at right is fitted with a concave roller at its far end, and it is this section that conveys the drill pipe down the V-ramp. The upper end with the roller rests on the edge of the derrick floor, while the open end in the foreground is placed inside the longer section of split casing shown at left. This second section, somewhat longer than the drill pipe, rests flat on the catwalk.

The crewmen on the floor break out a joint of drill pipe, and by using the catline, place the pipe in the upper section of the chute. The pipe glides down the chute into the horizontal section. The near end is sealed to serve as a stop for the pipe. Roustabout crews then rotate the bottom section and the drill pipe rolls out and onto the racks.



The Cranfield Cycling-Pressure Maintenance Unit

Part 2 - GENERAL OPERATIONAL PLAN

By LEO E. HINES
Division Production Engineer, The California Company

THE OVER-ALL operational plan of production and phases of the reservoir and production engineering associated with properly depleting the indicated reserves of the Cranfield field, are discussed in this article. The first part of the series treated of the basis of the Cycling-Pressure Maintenance Unitization Agreement.

THE Cranfield field, Mississippi, cycling plant, field gathering system and per well testing facilities were each designed after consideration had been given the proven reserves which were to be processed. Further, the design of the plant and field facilities each took into account an over-all reservoir production rate which was consistent with the maximum reservoir efficient production rate and the economics of recovery.

In conjunction with equipment, process and gathering system design, a detailed reservoir study was made to relate per well and total productions to these designs and vice versa, in order that the resulting operational plan would be consistent with an efficient dry gas flood of the sand; therefore, maximum ultimate recovery.

The following indicates the parallel purpose, and indicates further the reservoir engineering associated with the actual operation and production of the formation, such that maximum recovery of recoverable products would be obtained.

For the indicated reserves to be processed in a period of time best fitting the economic outlook (moreover, following sound engineering production principles), the plant and field gas gathering systems were designed to process and inject 100,000 thousand cubic feet per day. In effect, calculations for plant and field gathering system designs are predicated on the basis that 100 percent of the reservoir pressure would be maintained.

The plant was designed for two definitely different type gases, each to be gathered in the field. Figure 15 indicates field gathering system layout and relative plant location.

The gas cap gas, or total well effluent from the gas cap wells, would be produced directly to the plant inlet condensate separator without any field separation. However, a gathering system whereby the black oil could be separated from the formation gas in the field at 1700 pounds per square inch, was designed. The 1700 psi "stripped" gas stream would then be transported directly to the plant to be commingled in the high pressure absorbers with the gas cap residue gas production, which would come from the plant inlet condensate separator. Black oil from the 1700 psi separator in the field was then to be flashed to 500 psi with the resulting residue gas being transported to the plant. The black oil off the 500 psi field separators would then be produced to the plant to be processed through a black oil scrubber, heater treaters followed by commingling and storage in 5000-barrel tanks with the condensate which was recovered from the gas cap well's production. This condensate resulted from the initial flash from formation pressure to plant inlet condensate separator pressure. This vessel was designed to operate at 1600 psi. The line drawing, Figure 15, typifies the Cranfield gathering system layout.[4]

The Cranfield plant blended crude treating and gathering facilities were designed for 15,500 barrels per day. Blended Crude is a term used to describe all liquid hydrocarbon products produced by the Cranfield Unit wells without the aid of absorption. When used in connection with an individual well, it refers to the total stock tank liquid hydrocarbon produced by the well which would be measured in atmospheric stock tanks. This term is necessary since all field products produced and extracted at the plant without the aid of absorption are commingled in 5000-barrel tanks, and are never split into condensate and black oil except on a mathematical basis.

It has been previously explained in design features of the plant storage and field gathering systems that produced gas cap well condensate and black oil well liquid hydrocarbons, both of which have varying amounts of black oil and condensate in their makeup, are commingled in tanks at the plant. They are never split, except on a mathematical basis. A description of the mathematical basis of splitting the commingled blended crude into true gas cap and black oil band liquid produce, the result to be used for production records, will be explained. This record of produced products has been deemed necessary in order that reservoir performance of the black oil band and gas cap may be evaluated from time to time for critical comparisons to the time rate of depletion schedule, Figure 15.

Originally, numerous tests were made upon both true gas cap wells and solution ratio wells. In the course of these tests, samples of the true gas cap liquid condensate and true oil band black oil were analyzed in the laboratory for respective $iC_5\pm$ specific gravities. Resulting gravities were then used in computations to calculate a table which would indicate the percent condensate and black oil present in a sample of blended crude, if the specific gravity of the $iC_5\pm$ fraction of the blended crude were known. Formula used for these computations was:

$$D_b = D_c x + D_o (1 - x)$$

D_b = Specific gravity of the blended crude iC_5+
D_o = Specific gravity of the black oil iC_5+
D_c = Specific gravity of the condensate iC_5+
x = Percent of blended crude which is condensate
$(1-x)$ = Percent of blended crude which is black oil

Daily the produced blended crude volumes are reported by tanks; in addition, a specific gravity and a liquid volume percent of the iC_5+ fraction are made and reported for each tank.

The quantity of each produced type of product is calculated each day with subject table, the daily blended crude produced and a daily average weighted

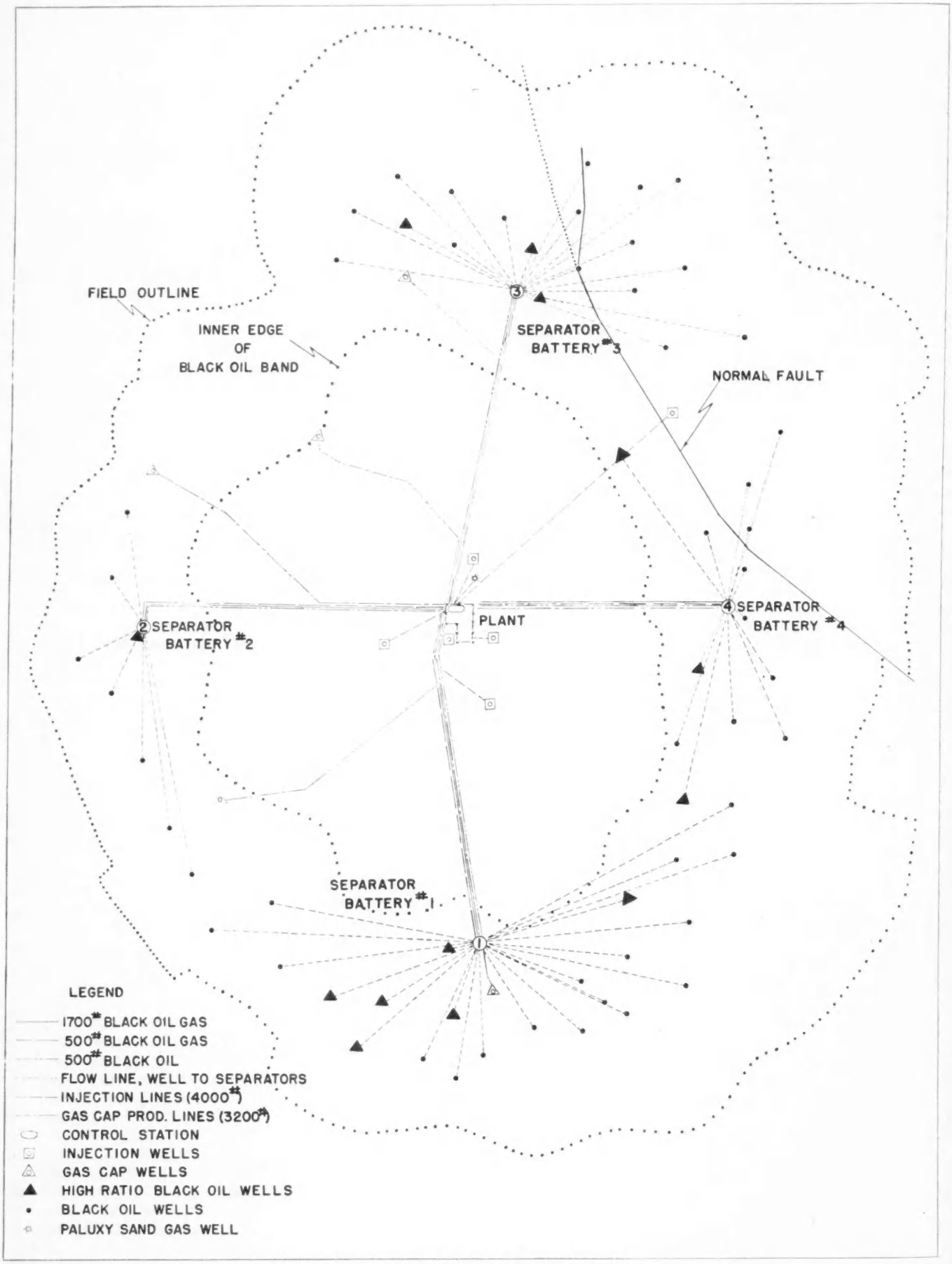


FIGURE 15. Plant and field gathering systems.

specific gravity of the iC_5+ fraction.

In the specific case of Cranfield's production blend, a calculation of the above nature may be considered valid, i.e., using iC_5+ specific gravities, since the liquid volume percent of the iC_5+ fraction, as determined daily, will not vary more than a fraction of a percent from day to day. However, the liquid volume, percent is checked each day, and should any continued deviation be detected, a mathematical compensation would, necessarily, be made.

When testing individual wells, a similar "split" of production is made; however, the determined gas-oil ratio is used as the criteria to calculate the percent condensate or gas cap liquid produced in the total stock tank liquid resulting from the producing well's effluent.

Individual Well Testing Facilities

Gas Cap Wells

The general layout of the field gathering systems is indicated by Figure 15. Figure 16 presents the individual gas cap well testing facilities.

From figures 15 and 16, it can be seen that each gas cap well produces directly to the plant where it may be tested "under pressure" with full scale equipment, i.e., the full well stream is tested for content. The term "under pressure" means that a well may be switched into this test separator where both the gas and liquid phases of the total well effluent are measured off the separator under pressure. The determined gas-oil ratio is termed the pressure GOR. This ratio is essentially the equilibrium GOR at the particular test pressure and temperature of the separator. See Figures 17, 18 and 19 for calculated equilibrium GOR5 curves, gallons per minute content of iC_5+ content of gas stream off the test separator and specific gravities of the resulting gas off the test separator, respectively. These curves are used as guides in pressure GOR determinations. The average pressure and temperature of Pressure GOR testing is 2000 psi and 120° F.

In any cycling plan, the periodic testing of the gas cap and black oil wells is an important phase of the operation, since results of the individual well tests are for the most part the only positive information available to the reservoir engineer for controlling the movement of the injected dry gas through the formation. It is true electric model analyses may be made for this purpose; however, any variation in permeability-sand thickness distribution from that used in flood pattern calculations will result in erroneously calculated shapes of these patterns. Further, uneven permeability stratification in the sand can lead to premature dry gas break through in unexpected places. By using the electric model to determine a theoretical flood pattern and the resulting production schedule, a first approximation to a proper sand flood can be made. Then continued well testing and a close maintenance of the production schedule, with adjustments in per well production rates when the need is indicated by quarterly depth pressure surveys, will result in a close approximation to the desired flood pattern. In time, the dry gas will break through to one of the gas well producers; it is at this time the periodic well tests (twice per month) will become important. It is with information from these that channel detection, sweep efficiencies, economic limits of production, production control, etc. must be determined.

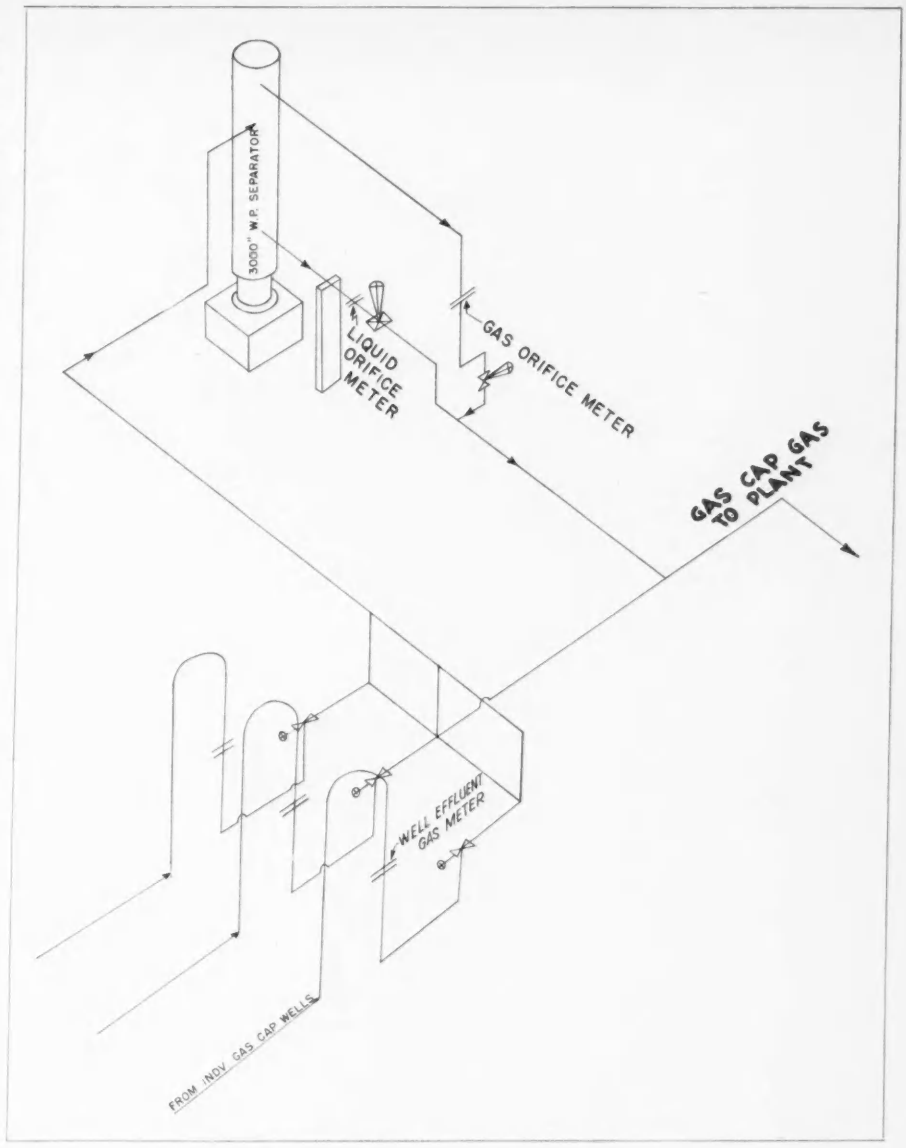


FIGURE 16. Gas cap testing facilities.

In making these tests, in the Cranfield cycling unit, the gas off the test separator is measured by NGAA recommended methods with proper correction for gas deviation from the true gas laws. The liquid off the separator, like the gas, is measured with an orifice meter; however, the coefficient of measurement is determined experimentally, using a calibrated section of the test separator for gauging the flowing liquid under pressure. This calibrated section has complete coverage of liquid level by gauge glasses; this gives the possibility of calibrating the liquid orifice meter by sight measurements of the produced liquid. The actual calibration of an orifice is accomplished by using the true volume rate of flow of the liquid from the well, as metered by the calibrated section of the test separator, and the resulting flowing differential reading recorded by the differential pen of the orifice meter chart. After applying proper temperature correction factors to the liquid volume, the coefficient is calculated by:

$$C = \frac{Q}{H}$$

C = 24 hr. corrected coefficient

Q = 24 hr. volume of pressure liquid gauged in calibrated section of the separator corrected for expansion due to temperature.

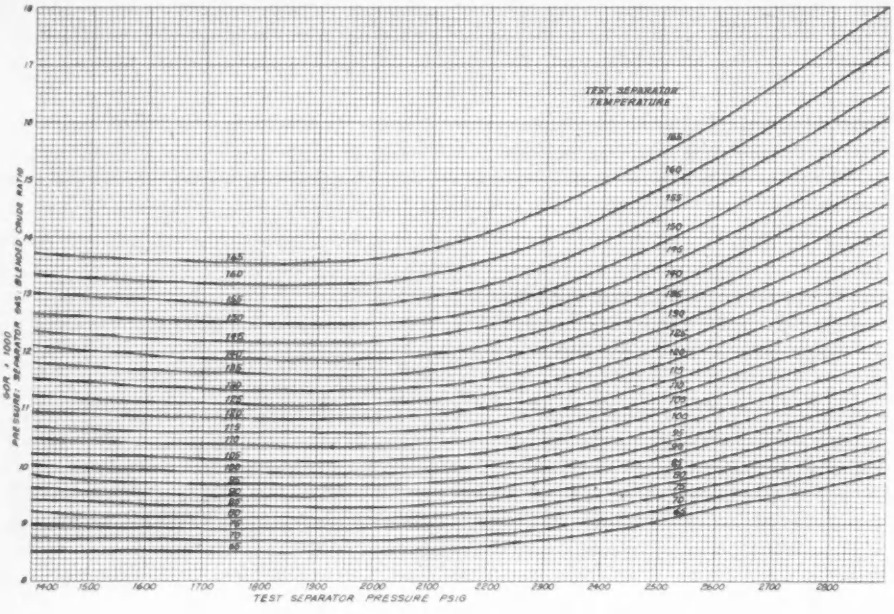


FIGURE 17. Pressure GOR curves.

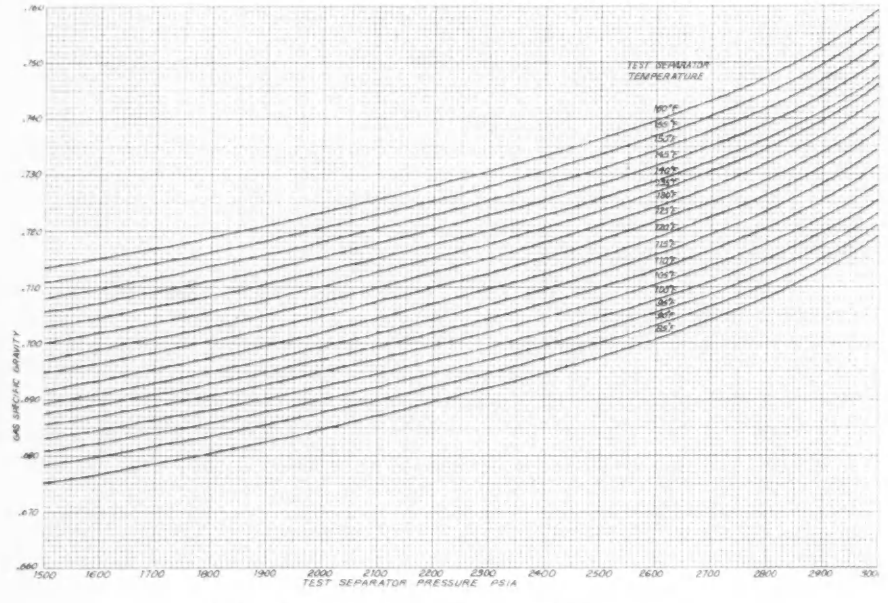


FIGURE 18. iC_5+ Content of gas off test separator.

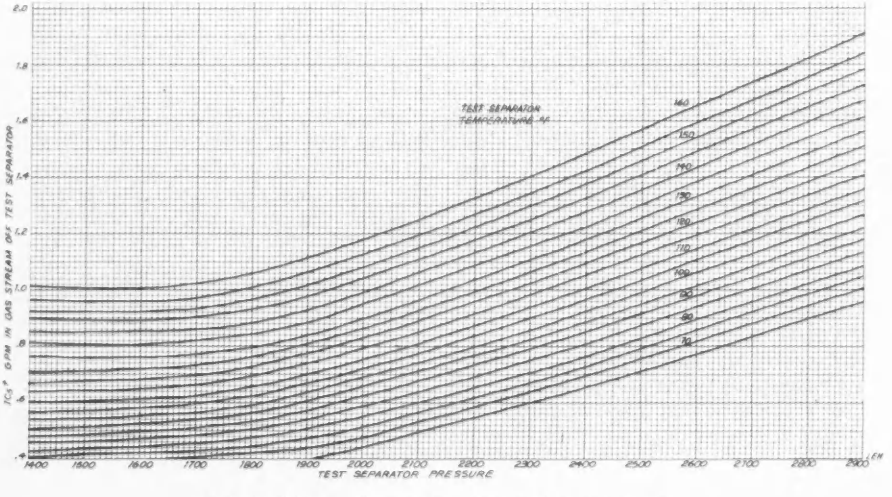


FIGURE 19. Specific gravity of gas off test separator.

H = The L-10 (square root chart) differential reading of the differential caused by passing Q bbls. of blended crude per day.

This method of orifice meter coefficient determination eliminates all the variables and unknowns of trying to calculate a coefficient for an extremely volatile liquid. However, it has been proven that the most reliable results of metering, in this manner, are obtained at low differential readings. This is due possibly to the fact that at high differential pressures across the orifice plate, flashed vapors will be present, thus causing an erroneous differential reading across the orifice plate.

The liquid of the test separator is at approximately 2000 psi; consequently, it has considerable volume of the lighter fractions in it, the result being, when this "pressure liquid" is flashed to atmospheric conditions, it shrinks by approximately 35 percent. To determine the volume of atmospheric liquid flowing requires the taking of a sample of "pressure liquid" into a specially built bottle, at separator pressure, then differentially liberating it to atmospheric conditions. After applying proper temperature corrections to the resulting liquid, a shrinkage factor is calculated.

The complement of the shrinkage factor is then multiplied by the measured volume of pressure liquid; the product is termed the atmospheric condensate; it is, approximately, the equivalent of an equal volume of liquid having been processed through the plant condensate extraction processes.

Depending upon the pressure and temperature of separation, the gas off the separator will have varying volumes of the iC_5+ fraction present in its analysis. A test, which consists of passing a volume of the gas through a gas tower emersed from a bath at —110° F., in order to "freeze" out the condensable liquid fractions of the gas, is made. Resulting liquid is weathered to 32° F., then corrected to 60° F. In addition to "freezing" out the liquid, the gas volume, from which the liquid was condensed, was also measured. With these two measurements, a gpm value can be calculated for the gas stream of the test separator. This value, like the pressure GOR, is then used as a dry gas indicator; it is also used in the mathematics of compiling individual gas well production records.

In addition to the semi-monthly well tests on gas wells, further well testing consists of taking gas and liquid samples off flow streams of the test separator, when warranted by the GOR tests. Samples are analyzed by the low temperature fractional distillation method. These samples are then mathematically recombined to determine the reservoir analysis

for comparison to original tests of the same nature. Economic evaluations are then calculated relating to "shut in date" or "continued production" for the individual well in question.

Black Oil Wells

Figure 20 shows the conventional field separator battery installation for the processing of black oil well production to the plant. Individual well testing facilities are also shown.

Black oil wells are all tested monthly at the separator batteries, using the indicated 1700 and 500 psi separators. The liquid from the 500 psi separator is flashed to a 50 psi separator then to stock tanks (not shown), where it is gauged. After each individual black oil well test, the resulting blended crude is pumped from the test tank into the separator battery black oil line, thereby being transported to the plant and storage as previously described.

Maintaining Unitization Reservoir Pressure

Calculations, for the Basal Tuscaloosa sand, based upon presented reservoir sand and fluid parameters, indicate a serious loss to gross returns for each pound loss in reservoir pressure. This loss would, of course, be the result of retrograde condensation in the gas cap, decreased black oil recovery resulting from the liberation of solution gas, and finally, an increased lifting cost to black oil wells because of the necessity of artificially lifting the oil to be produced and large accompanying volumes of water after the reservoir pressure falls below 4000 psi.

With due consideration to itemized losses and expected lifting cost increases, plans have been formulated to maintain 100 percent of the unitization date reservoir pressure, or at least as nearly as possible, with the extraneous gas supply which is available to the unit. In order to effect a plan of this nature, calculations show the necessity of 74,000,000 mcf extraneous gas for injection purposes during the cycling-pressure maintenance period.

Tables 8 and 9 give the Paluxy Formation credit for a gas volume of 37 299,000 mcf of which 30,220,000 mcf have been calculated as recoverable at a 1000 psi abandonment pressure. This volume is available, immediately, for injection purposes.

From Table 5 of Part 1 of the article, it can be seen that the Paluxy sand gas is 99.75 percent carbon dioxide and methane, essentially a dry gas. Table 5 also shows the calculated Paluxy sand reserve at a static abandonment reservoir pressure of 1000 psi. Voidage calculations indicate the necessity of 21 million cubic feet per day of extraneous gas to maintain 100 percent reservoir pressure in the Basal Tuscaloosa sand. Calculations based upon the Paluxy reservoir parameters, etc., indicate the possibility of a considerable drawdown in pressure across the sand face in the latter producing life of this reservoir, that is, when producing at the desired flow rate of 21 million cubic feet per day. This fact will necessitate a decrease in daily production rate for this sand, one well system, in approximately three to four years. Naturally, proportionate falls in the Basal Tuscaloosa reservoir pressure will result from this decreased daily rate of extraneous sand gas injection.

Gas from the Paluxy Formation, however, may be expected to supply sufficient makeup gas to maintain 100 percent reservoir pressure for at least four years of the cycling-pressure maintenance period. After that, further maintenance of 100 percent reservoir pressure will depend upon whether or not extraneous

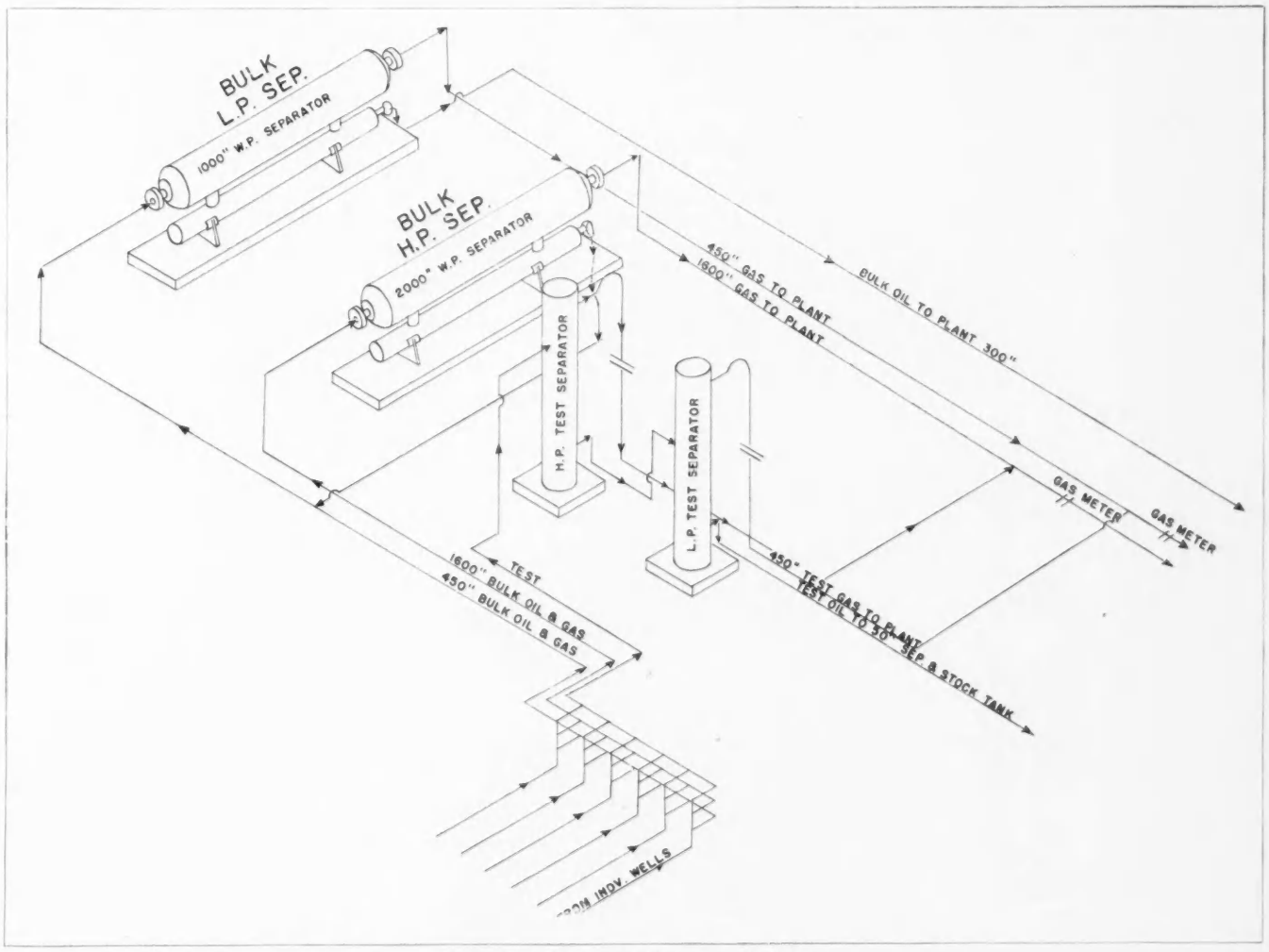


FIGURE 20. Black oil bulk and test facilities.

gas is continued to be brought into the unit and injected into the formation. The economics of this situation will be evaluated in 1950, and assuming the additional recovery which is to be effected by continuing to maintain 100 percent reservoir pressure justifies the expense, the purchase of extraneous dry gas will be considered for the job.

Establishing Production Rates

To properly produce any reservoir such that the maximum economic recovery may be obtained, a detailed study should be made relating reserves and "daily take" to the controlling production characteristics of the formation. In addition, an over-all plan of reserve depletion should be devised which is cognizant with the established maximum, efficient, economic rate of production. It is generally accepted, though doubted by some,[6] that the greatest "barrel" recovery will be obtained by producing from a reservoir at low to moderate rates of flow. Possibly this may be true, but there are rates of production somewhere between "too small" and "too large" for a sand, whereby the largest monetary gain will be made. This is logical, since "too small" daily rates are conducive to long pay out periods and high lifting costs; on the other hand, it is the general belief that the "too large" daily rates result in a general low ultimate recovery.

In order that the maximum, economic, efficient daily rate of production could be estimated, numerous per well production and injection tests* were conducted prior to unitization by all operators. The resulting field total daily production rate of both the black oil band and the gas cap, naturally, is the sum of the respective individual well productions. However, the two definitely different type materials must be produced at governed rates. The production rates for the respective reservoir materials are consistent with equipment design, ultimate recovery and economics of the situation.

It has been calculated that 78 percent of the existing recoverable black oil reserves in the reservoir, as of the initial date of unitization, will be recovered during the cycling-pressure maintenance period. The remaining 22 percent will be recovered on the "blow down" stage of the over-all production plan. However, the distribution of this total production, in future years, will necessarily reflect an individual well's producing characteristics, and detailed electric model sand flood studies used in conjunction with well tests and quarterly depth pressure surveys. This will be necessary, in order that each well will contribute its proportionate part to properly flooding the sand with dry gas; in addition, that each well will recover the recoverable oil and gas within its respective drainage radius.

After a certain time, in a cycling-pressure maintenance plan, where dry gas is injected in the top of a structure, some of the producing wells will be invaded by the dry gas; the net result will be that for economic reasons subject wells will have to be shut in. However, the daily time depletion rate of the reserves must be met, if possible; therefore, an adjustment in per well allowables must be made. These adjustments must be consistent with the continuance of efficient reservoir flooding, also plant and field gathering system capacities.

Black oil wells' production rates must, each month, be checked and controlled, since, with the depletion of the black oil, the gas cap will gradually expand into the black oil band. It is the general plan to allow the gas cap to sweep into as many black oil wells as possible for the purpose of increasing the black oil recovery. However, this must be a closely controlled process, as any channeling effect will result in a general loss in recovery. Another reason for allowing the gas cap to sweep into the black oil band is in the case of a well beginning to produce water, an increase in GOR, resulting from the invading gas cap gas, will greatly lower lifting costs. This is evident, since this type well will continue to flow under its own "power," thus keeping lifting costs near a minimum. As previously stated, however, the process of gas cap expansion must, necessarily, be closely controlled or the net result will be a general loss in recovery.

No water drive of commercial magnitude exists in the Cranfield Field's Basal Tuscaloosa reservoir; however, there is some edge water encroachment due to the replacement of voidages near the structure's edge. This water encroachment is the direct result of reservoir withdrawals or production. Although a 100 percent voidage return is made to the formation by injection of dry gas, and the average weighted pressure remains constant, the structure's edge will experience a general reservoir pressure decline due to production withdrawals, and the factors involved in total pressure propagation from the injection area. Water will encroach into the black oil band due to these permanent reservoir pressure falls.

Present and future reservoir pressure adjustments, of course, are the net result of the overall injection-production schedule; however, this pressure redistribution may further be explained by the fact that reservoir fluid is attempting to reach a steady state flowing condition, thus causing the reservoir pressure to be redistributed proportionally to the effective radial permeability thickness of the sand and the geometry of the producing system from the injection area out.

As the result of this redistribution of reservoir pressure, numerous tests must be made on the edge black oil wells for the purpose of production control.

* Pilot injection started one year before the official date of unitization. The original discovery well, National Gasoline No. 1, was used. Numerous tests of a varying nature were made upon this well to determine some of the reservoir injection characteristics, etc.

TABLE 8

Unitization—Recoverable Reserves

	Black Oil Tank Barrels	Black Oil Solution Gas * MCF	Reservoir Gas Cap Gas in Place MCF	Total Formation Gas MCF
Basal Tuscaloosa	49,271,000	86,984,000	332,319,000	419,303,000
Paluxy	.....	.....	37,299,000	37,299,000

TABLE 9

Reserves—To Be Recovered During Cycling Pressure Maintenance Period

	Black Oil Tank Barrels	Black Oil Solution Gas *	Reservoir Gas Cap Gas in Place MCF	Reservoir Gas Cap Gas W/Recovery & Recycle Factors MCF	Total Recoverable Formation Gas W/Recovery & Recycle Factors MCF
Basal Tuscaloosa	38,431,000	41,275,000	332,319,000	302,410,000	356,067,000
Paluxy	.....	.....	37,299,000	39,286,000	39,286,000

(*) All gas volumes at 14.7 psi. and 60° F.
(†) Reflects condensable hydrocarbons plus dry gas in gaseous state at reservoir conditions.

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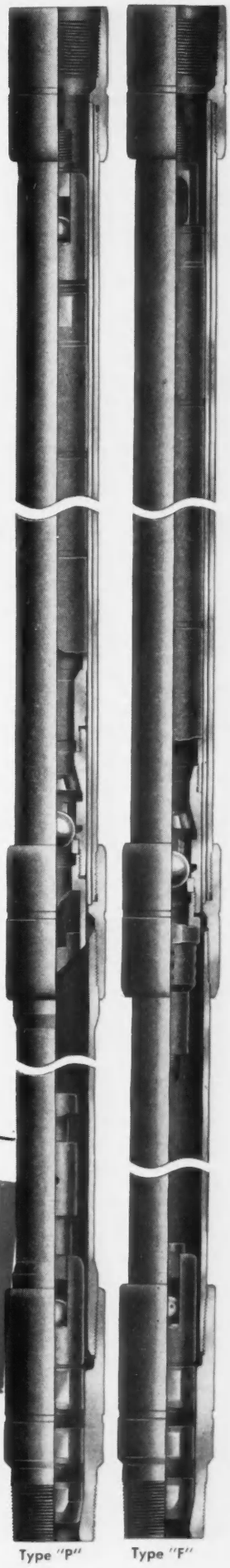

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Flooding Prospects of Illinois Basin

By
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Petroleum Engineer
and
PAUL G. LUCKHARDT
Formerly Assistant Geologist,
Illinois State Geological Survey

THE success of applied floods in the Siggins, Patoka and Basin McClosky oil pools, which have produced more than $25 million worth of oil as a result of flooding, and the greatly increased production due to accidental floods and encroaching edge-water, have encouraged a search for other favorable flooding prospects. This article is an effort to examine and evaluate a number of such flooding possibilities.

As there are more than 300 oil pools in Illinois, to cover all of them becomes a long-range project. The present article treats pools having only one predominant sand. Such pools occur in the Waltersburg, Tar Springs, Cypress, Bethel, and Aux Vases sands and the McClosky lime. Examples of each have been selected.

These pools are shown in solid black

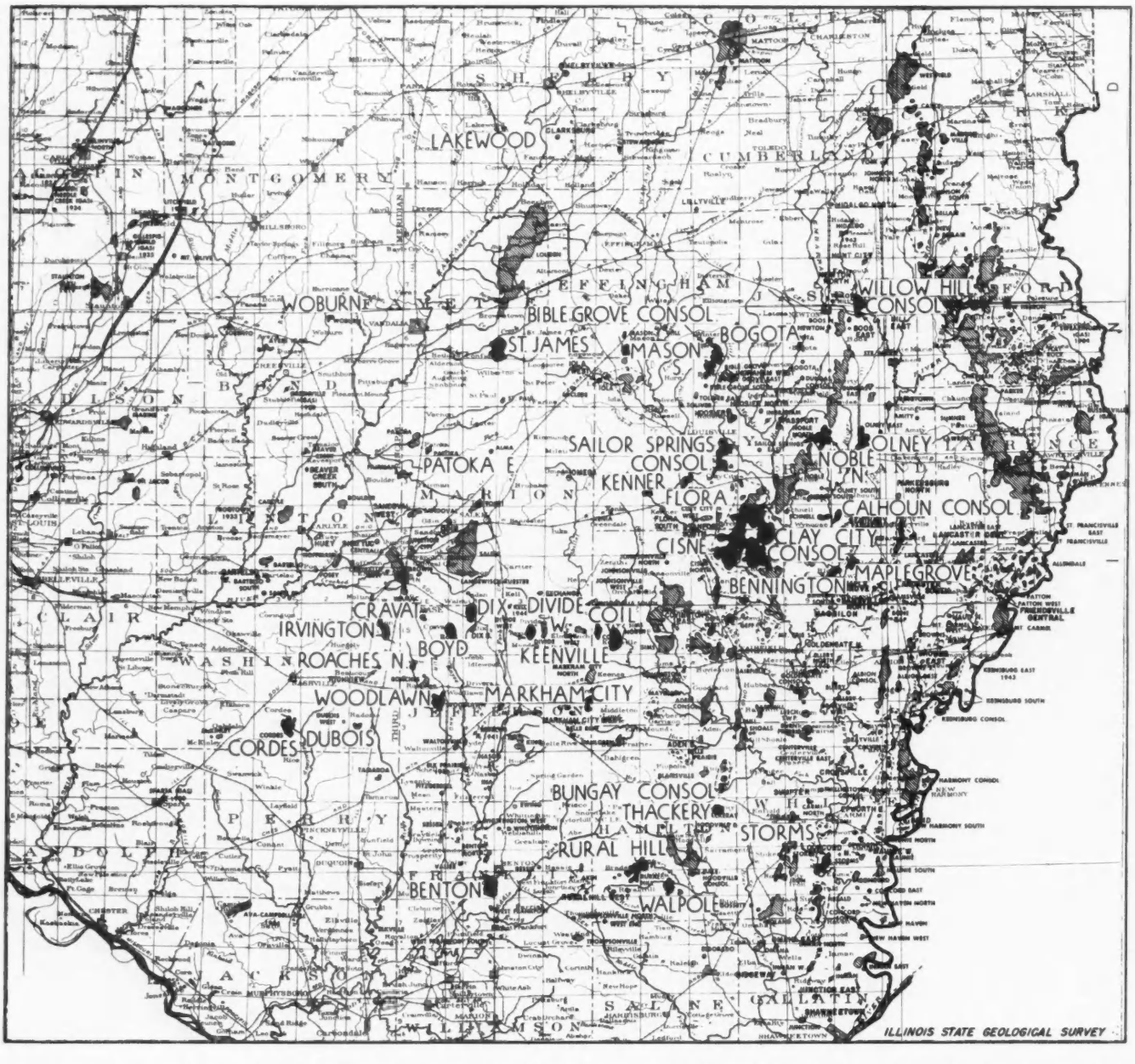


FIGURE 1. Map of the Illinois basin oil fields, with the pools described in this paper marked in solid black, showing positions of surface streams relative to oil pools.

Oil Sands

in Figure 1 which also locates, by hachured lines, most of the other Illinois oil-producing areas.

The sequence in depth of the sands in the selected pools is shown in the geologic column, Figure 2.

Since many of the characteristics of the sands, such as depth and thickness, in the fields discovered since 1936 are listed in Illinois Petroleum No. 58[1] these are not repeated in the present article, but the reader is referred to them. They are here amplified by additional information more pertinent to the evaluation of the pools for water-flooding: the viscosity and gravity of the oil, the porosity, permeability, water and oil saturation of the sand, and the initial position of edge water. Studies now in progress for the same pools include water analyses, gas-oil and water-oil ratios, and the degree of edge-water encroachment.

Photomicrographs of core samples from six formations . . . five sandstones and one limestone . . . are shown in Figure 3. In general these samples are from parts of the formation much less porous and permeable than the average. Determinations of porosity and permeability of the samples illustrated were made by Paul M. Phillippi. They show the following conditions:

Formation	Porosity (percent)	Permeability (millidarcys)
Waltersburg	16.43	130
Tar Springs	15.29	84
Cypress	17.32	27
Bethel	17.65	60
Aux Vases	13.33	0
McClosky	19.18	878

The Waltersburg has been successfully flooded in the New Harmony pool, the Tar Springs sand in the Maunie South pool, the Bethel in the Patoka pool, and the McClosky in several areas on the Nobel anticline.

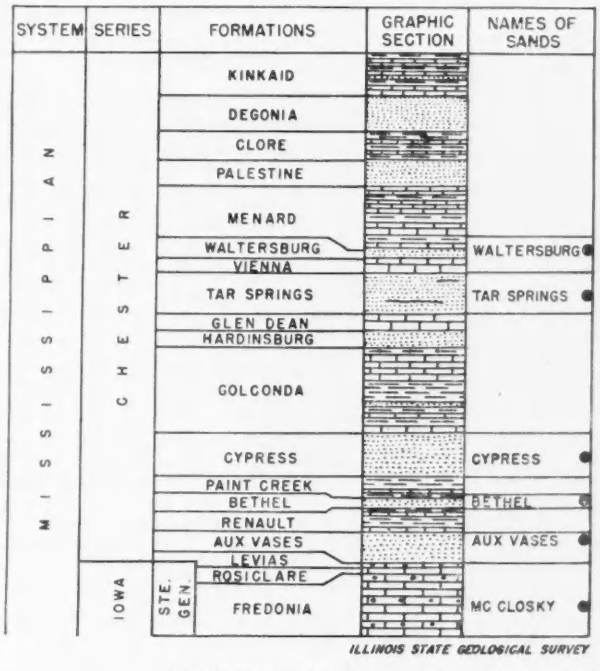
Table 1 gives the principal characteristics of each sand.

Figures 1 and 4 show known and possible fresh water supplies which are supplemented by Table 2, naming probable salt water-bearing sands above the oil

TABLE 1

Principal Characteristics of Oil Sands

POOL	Sand	Porosity	Permeability	Water Saturation	Oil Saturation	A.P.I. Gravity	Viscosity Centipoises at 100°F.	Cumulative Bbls. per Acre
Storms	Waltersburg	19-25	28-1200	10-43	10-24	32.1	6.80	3379
Sailor Springs	Tar Springs	10-19	15-1680	28-52	11-41	37.0	5.26	1435
Benton	Tar Springs	15-23	16-2200	20-50	15-25	....	4.62	7954
Patoka East	Cypress	21-25	550-700	27-43	23-37	36.0	6.20	5788
Noble North	Cypress	12-20	10-6000	25-50	15-28	....	....	2078
St. James	Cypress	12-26	10-360	35-70	10-40	34.4	7.97	5171
Bible Grove	Cypress	11-23	10-42	31-62	10-33	....	....	1649
Kenner	Bethel	11-16	14-100	19-58	11-22	....	6.20	900
Woburn	Bethel	....	....	....	....	36.7	5.58	2455
Lakewood	Bethel	19-21	220-620	26-37	30-42	31.7	....	720
Roaches North	Bethel	....	....	....	....	....	....	2185
Mason South	Bethel	10-19	13-276	24-49	10-30	....	....	1844
Dix	Bethel	....	....	....	....	38.0	4.30	2979
Woodlawn	Bethel	12-20	32-600	19-50	10-24	37.8	4.94	6227
Irvington	Bethel	15-21	20-2900	26-48	20-40	37.6	3.96	4410
Cordes	Bethel	13-25	22-2145	30-50	15-50	37.4	4.94	2257
Cravat	Bethel	15-18	72	27-37	36-38	35.4	5.26	2225
Dubois	Bethel	....	....	....	....	31.0	8.54	1436
Boyd	Bethel	12-24	15-2200	15-47	15-25	....	4.30	3175
Rural Hill	Aux Vases	10-28	10-1202	30-64	10-21	....	....	3124
Coil	Aux Vases	11-19	10-x	10-19	46-60	....	7.68	2098
Thackeray	Aux Vases	....	....	....	....	....	....	3028
Walpole	Aux Vases	10-21	11-200	44-65	17-33	38.4	5.26	2958
Bungay	Aux Vases	17-26	14-650	41-64	10-30	....	....	2540
Flora	McClosky	....	....	....	....	37.2	4.62	1292
Calhoun Consolidated	McClosky	10-16	11-200	....	10-13	....	5.90	1201
Maple Grove	McClosky	10-15	100-250	37-82	x-x	....	3.61	1453
Cisne	McClosky	15-20	189-590	10-12	28-34	....	....	3008
Bennington	McClosky	x-x	x-x	x-x	x-x	....	....	1522
Keenville	McClosky	12-17	10-x	40-54	16-27	....	....	1500
Markham City	McClosky	10-16	12-2400	10-48	10-22	....	5.90	1465
Divide West	McClosky	....	....	....	....	....	5.58	2153
Olney	McClosky	11-15	11-500	20-28	19-25	37.2	4.94	1969
Bogota	McClosky	....	....	....	....	....	4.62	1790
Willow Hill	McClosky	....	....	....	....	....	....	909
Clay City	McClosky	10-26	45-9000	38-56	10-39	36-39.8	3.96-5.90	2017



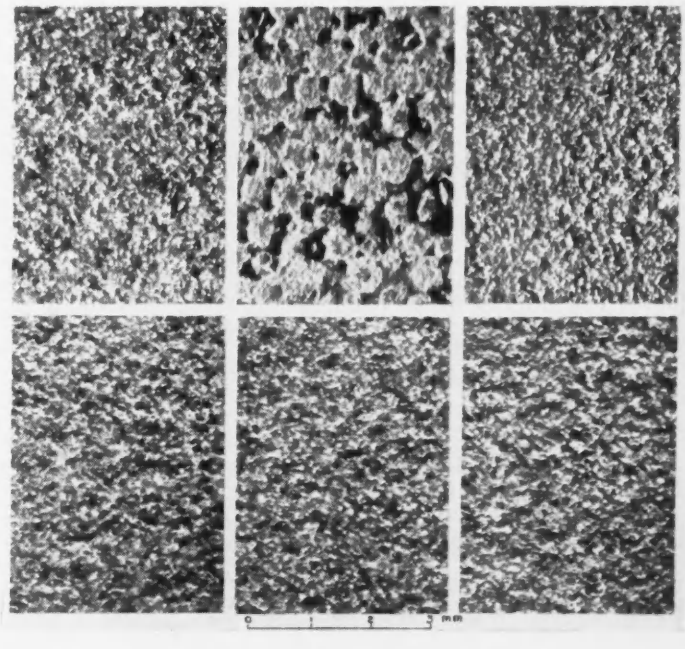


FIGURE 2. (left). Geologic column showing by black dots the producing sands which occur in the pools described.

FIGURE 3. (Right) Photomicrographs of core samples from the Waltersburg, Tar Springs, Cypress, Bethel, Aux Vases and McClosky sands.

sand for each selected pool. Figure 1 also shows the surface waterways. Only the larger of them will be adequate for intensive flooding throughout the year. Figure 4 indicates the areas of presumably water-bearing sands and gravels and fresh water-bearing Pennsylvanian sandstones.

Figures 5-9 illustrate the 36 pools described. On each is a line surrounding all wells which showed no water in their initial production. Wells outside these lines showed water initially. Those wells which are surrounded by a circle made more water than oil.

The Benton pool (Figure 5) is being made ready for flooding and has great promise. The Bethel sand pools shown in Figure 6 are likely to be under edge-water pressure. In this group the flooding operation at Patoka met with great success and Woodlawn seems to be very promising. In Figure 7, the Rural Hill pool covers a large area and its record in all respects seems favorable to flooding.

Figure 8 shows McClosky production. Wherever tested this formation has responded to water-flooding. On it has been developed the unique process of using only old wells as input wells, the water being supplied from upper sands in the same flooding well affording

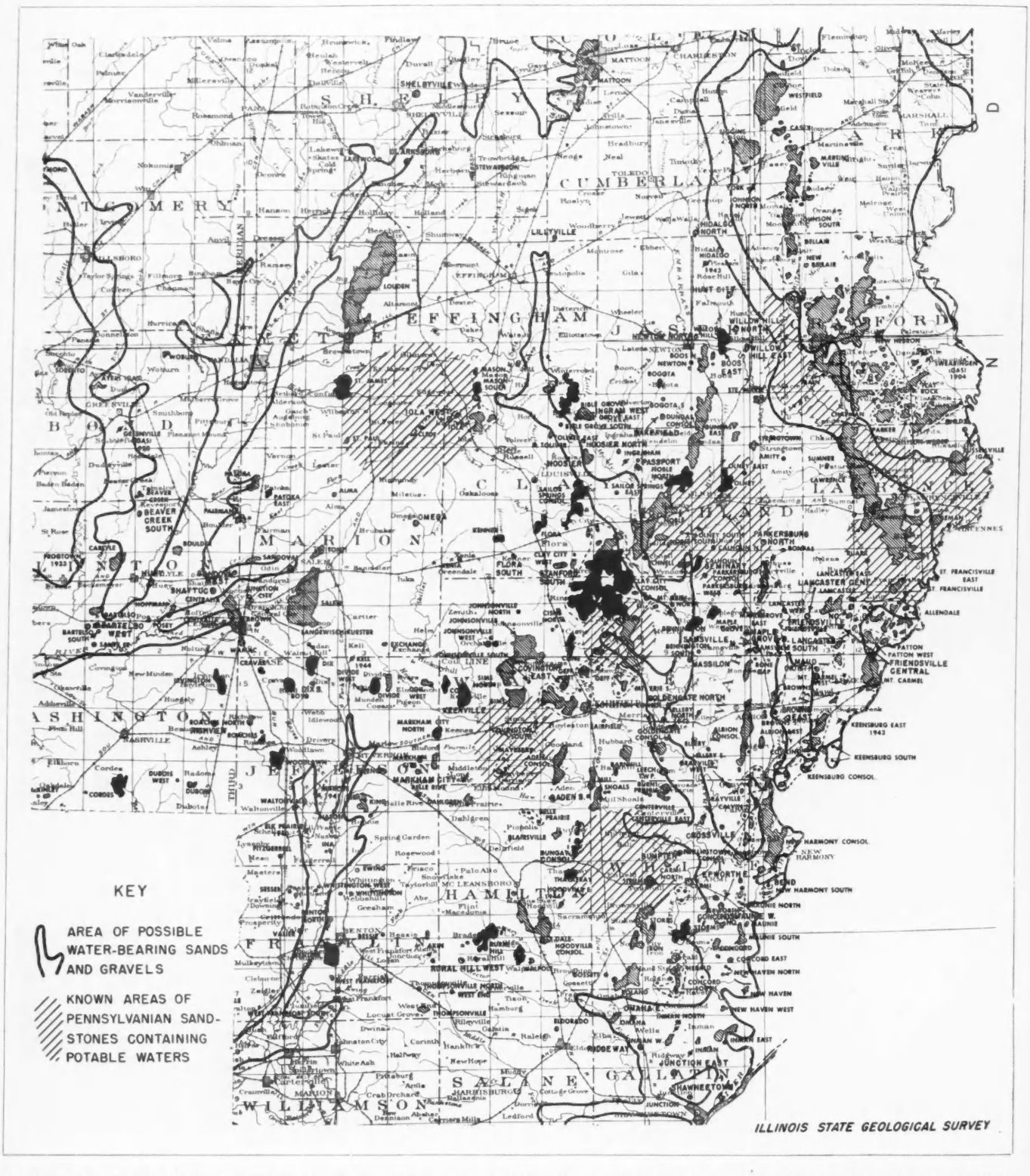

KEY
AREA OF POSSIBLE WATER-BEARING SANDS AND GRAVELS
KNOWN AREAS OF PENNSYLVANIAN SANDSTONES CONTAINING POTABLE WATERS
ILLINOIS STATE GEOLOGICAL SURVEY

FIGURE 4. Areas of possible fresh water-bearing sands and gravels and the known areas of Pennsylvanian sandstones that contain fresh water. By C. A. Bays.

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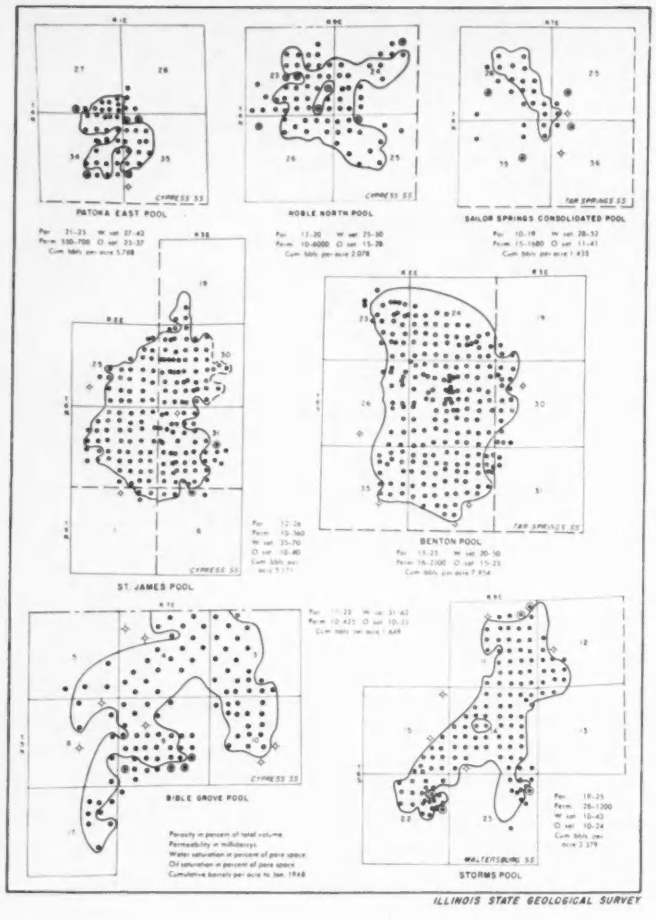


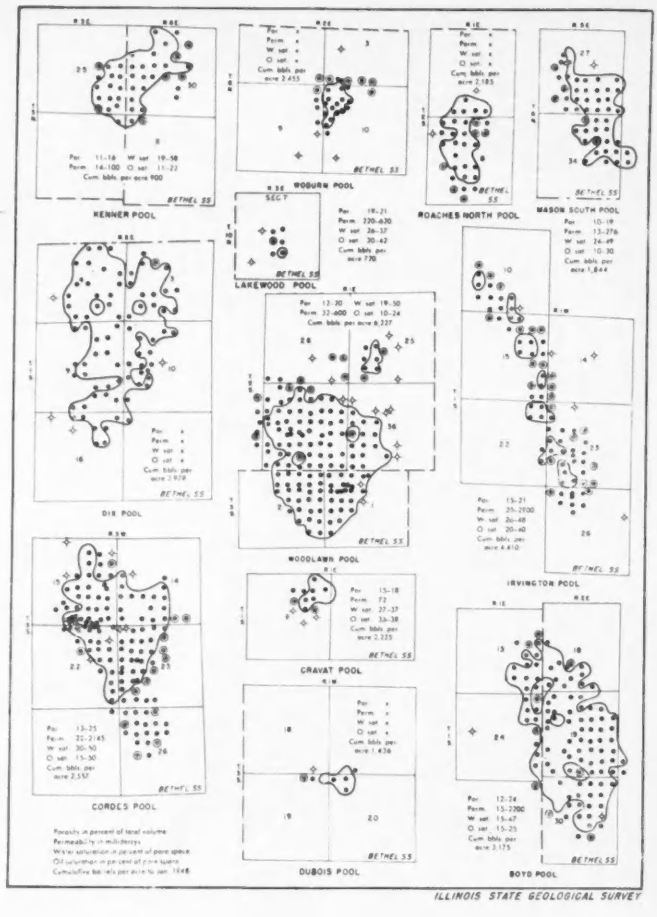
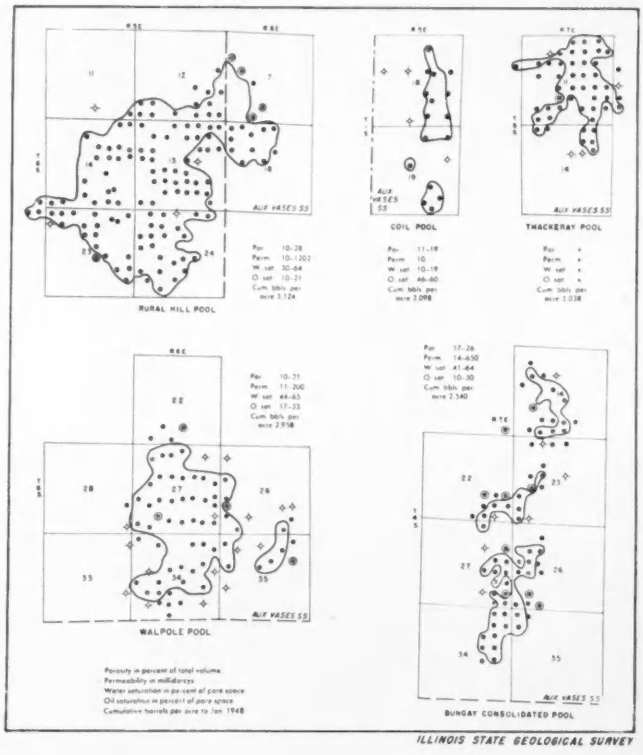


FIGURE 5. (Above left). Four pools in the Cypress sand, two in the Tar Springs sand, and one in the Waltersburg sand.

FIGURE 6. (Above, right). Twelve Bethel sand pools.

FIGURE 7. (Lower right). Five Aux Vases sandstone pools.



KEY TO SYMBOLS USED IN FIGURES 5-9.

Solid dot: Producing oil well.

Open circle with arms: Dry hole.

Solid dot within circle: Well initially produced more water than oil.

Boundary line: Boundary of pools which made no initial water. A second boundary in a few pools surrounds interior wells which produced initial water.

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The large Clay City Consolidated pool and three smaller pools are shown in Figure 9. Clay City is part of the McClosky production found by The Pure Oil Company on the Noble anticline where several successful McClosky water floods have been developed.

Figure 10 shows the areas now being flooded or being made ready for flooding. The characteristics of their sands may be compared with those of unflooded areas as a test

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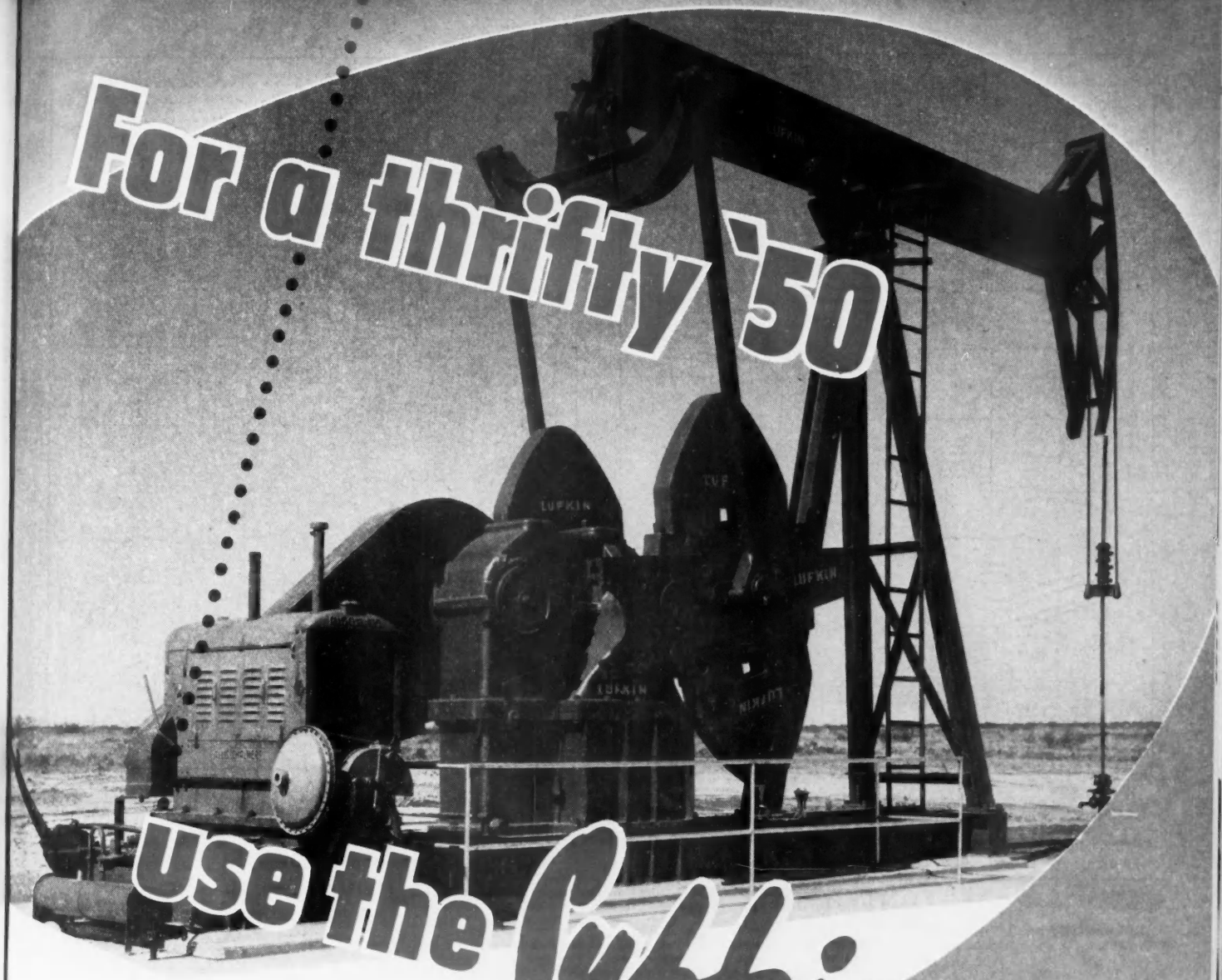

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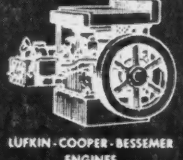

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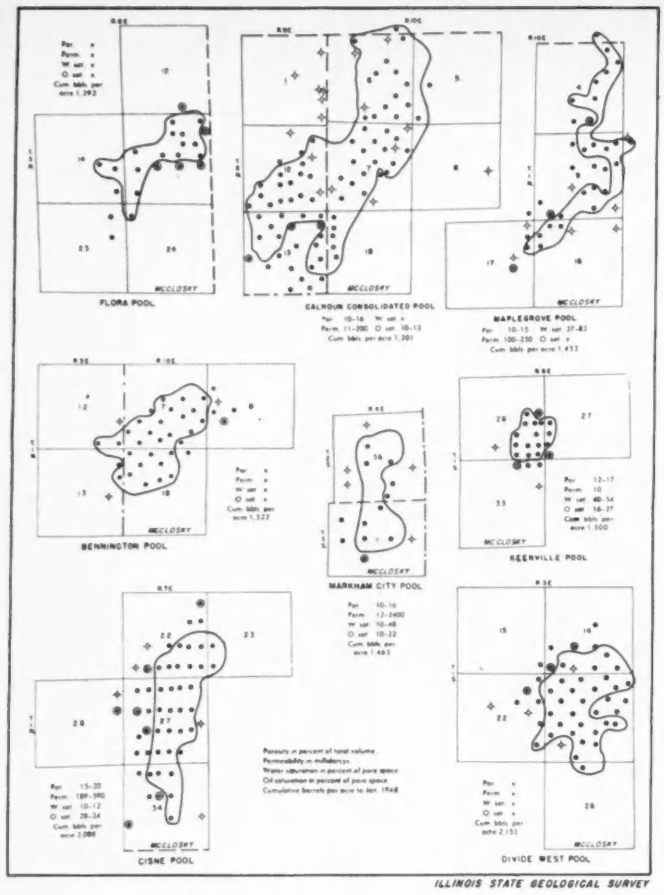

FIGURE 8. (Left). Eight McClosky limestone areas.

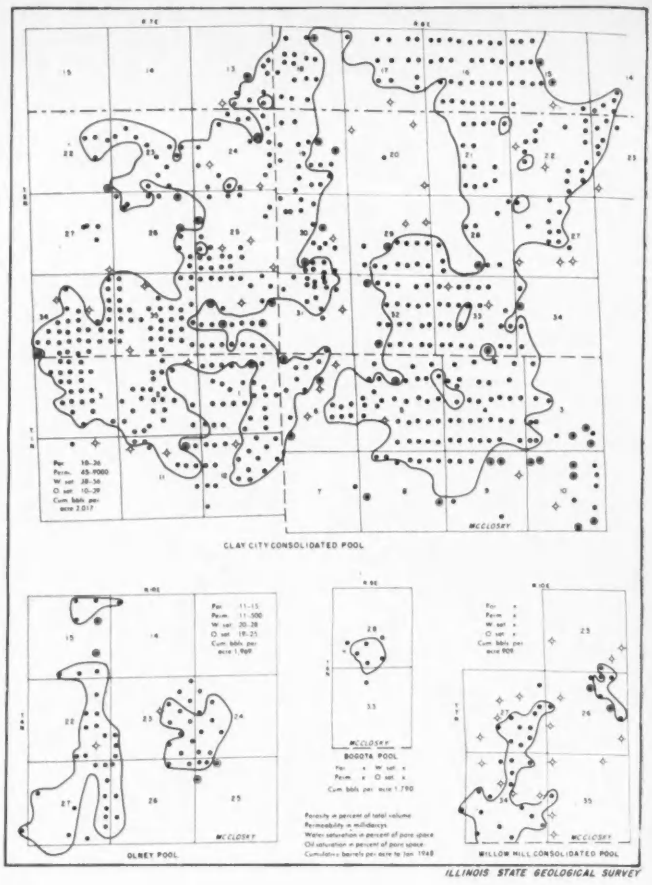

FIGURE 9. (Right). The large Clay City Consolidated pool and three smaller pools.

TABLE 2. Probable Sources of Salt Water for Flooding
(By DAVID H. SWANN)

POOL*	Sand	Occurrence of Upper Salt Water
Storms	Waltersburg	Probably available from lower Pennsylvanian sandstones around 1500 feet in depth. The Tar Springs has been a well-developed "water sand" in some of the surrounding dry holes.
Sailor Springs Consol.	Tar Springs	
Benton	Tar Springs	May be available from several lower Pennsylvanian sandstones at a depth of 1100 to 1800 feet, but none are continuously developed. The Hardinsburg sand, 2200 to 2300 feet, may be a possible source beneath some parts of the field.
Patoka East	Cypress	Tar Springs sandstone, about 1100 feet, and Cypress sandstone.
Noble North	Cypress	Available in lower Cypress sandstone, about 2600-2700 feet, Tar Springs sandstone about 2300 feet, and several sandstones in lower Pennsylvanian, 1600-2000 feet.
St. James	Cypress	Probably available in some parts of pool from Tar Springs sandstone, about 1400 feet, and from an upper Pennsylvanian sandstone, McLeansboro group, about 500 feet.
Bible Grove Consolidated	Cypress	Available in most parts of pool in lower Pennsylvanian sandstone, about 2000 feet.
Kenner	Bethel	In Cypress sandstone, about 2600 feet.
Woburn	Bethel	In Cypress sandstone, about 900 feet.
Lakewood	Bethel	Cypress sandstone, about 1600 feet.
Roaches North	Bethel	Probably in Tar Springs sandstone, about 1500 feet, and possibly in several lower Pennsylvanian sandstones between 1000 feet and 1300 feet.
Mason South	Bethel	Possibilities from Tar Springs sandstone about 1900-2000 feet, Cypress sandstone, about 2200 feet and various lower Pennsylvanian sandstones around 1400 feet; none continuous.
Dix	Bethel	Possibly in some parts of pool from Cypress sandstone, about 1800 feet, and in some parts from Tar Springs sandstone, about 1500 feet.
Woodlawn	Bethel	In Tar Springs sandstone, about 1500 feet, and in lower Pennsylvanian sandstones, 1000-1200 feet.
Irvington	Bethel	In Tar Springs sandstone, about 1100-1200 feet.
Cordes	Bethel	From lower Pennsylvanian sandstones, 600-700 feet and Tar Springs sandstone, about 800 feet.
Cravat	Bethel	In Cypress sandstone, about 1900-2000 feet.
Dubois	Bethel	In Tar Springs sandstone, about 900-1000 feet.
Boyd	Bethel	From Tar Springs sandstone, 1600-1700, and in parts of the pool from Cypress sandstone, about 1900-2000 feet.
Rural Hill	Aux Vases	In Cypress sandstone, about 2800-2900 feet.
Coil	Aux Vases	In Cypress sandstone, about 2600-2700 feet.
Thackeray	Aux Vases	
Walpole	Aux Vases	Probably available in portions of the pool from Cypress sandstone, about 2800 feet and from Pennsylvanian sandstone, about 1500-1700 feet.
Bungay Consolidated	Aux Vases	From Cypress sandstone, about 3000-3100 feet.
Flora	McClosky	From Cypress sandstone, about 2700 feet.
Calhoun Consolidated	McClosky	In Cypress sandstone, about 2700-2800 feet.
Maplegrove	McClosky	Possibly available in Cypress sandstone about 2900-3000 feet, and probably in lower Pennsylvanian sandstones, 1600-2000 feet.
Cisne	McClosky	From Cypress sandstone, about 2800-2900 feet.
Bennington	McClosky	In Cypress sandstone, about 2900-3000 feet.
Keenville	McClosky	In Cypress sandstone, about 2800 feet.
Markham City	McClosky	In Cypress sandstone, about 2700-2800 feet.
Divide West	McClosky	Possibly in Cypress sandstone, about 2400 feet, in some parts of the pool, possibly in Pennsylvanian sandstones about 1400-1600 feet.
Olney	McClosky	From lower Pennsylvanian sandstones, 1700-1900 feet, and Cypress sandstone, 2700-2800 feet.
Bogota	McClosky	From Cypress sandstone, 2800-2900 feet.
Willow Hill Consolidated	McClosky	From Cypress sandstone, 2400-2500 feet.
Clay City Consolidated	McClosky	In many spots from Cypress sandstone, about 2700-2800 feet, or Tar Springs sandstone, about 2400 feet.

* For location, see Figure 1.

for their probable reactions.

Summary

Thirty-six pools have been selected for study, positions of which are marked on a key map. Many of the characteristics of their producing sands are shown in Illinois Petroleum No. 58 for 1947. Other qualities more directly connected with water flooding, such as the position of surrounding water, the measure of viscosity of the oil, porosity, permeability, water and oil saturations of the sand, and the position of water for flooding in relation to the position of the pools are shown on maps and explained in the text. A map gives the locations of existing flooding operations, and deductions are made as to likely flooding prospects.

ACKNOWLEDGEMENTS

The writers are grateful to Alfred H. Bell, David H. Swann, Richard Cassin, Carl A. Bays, Leland Horberg and Paul M. Phillippi, who have given valuable assistance. Published by permission of the Chief, Illinois State Geological Survey, Urbana, Illinois.

REFERENCE

[1] Bell, Alfred H., and Kline, Virginia, Oil & Gas Development in Illinois in 1947. Ill. Geol. Survey, Ill. Pet. 58, 1948.

(See Map on Page 154)

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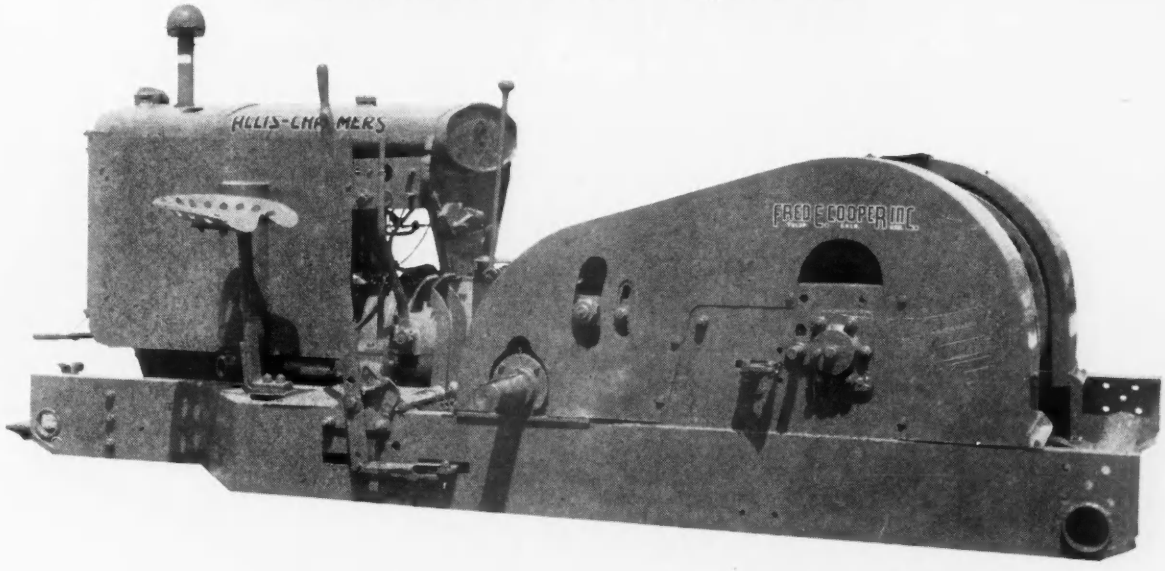

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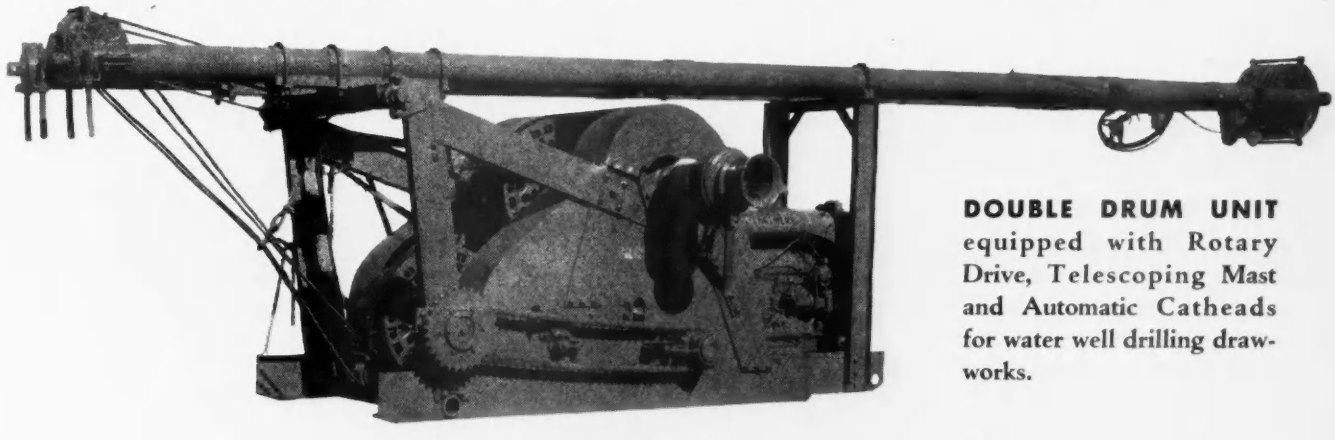

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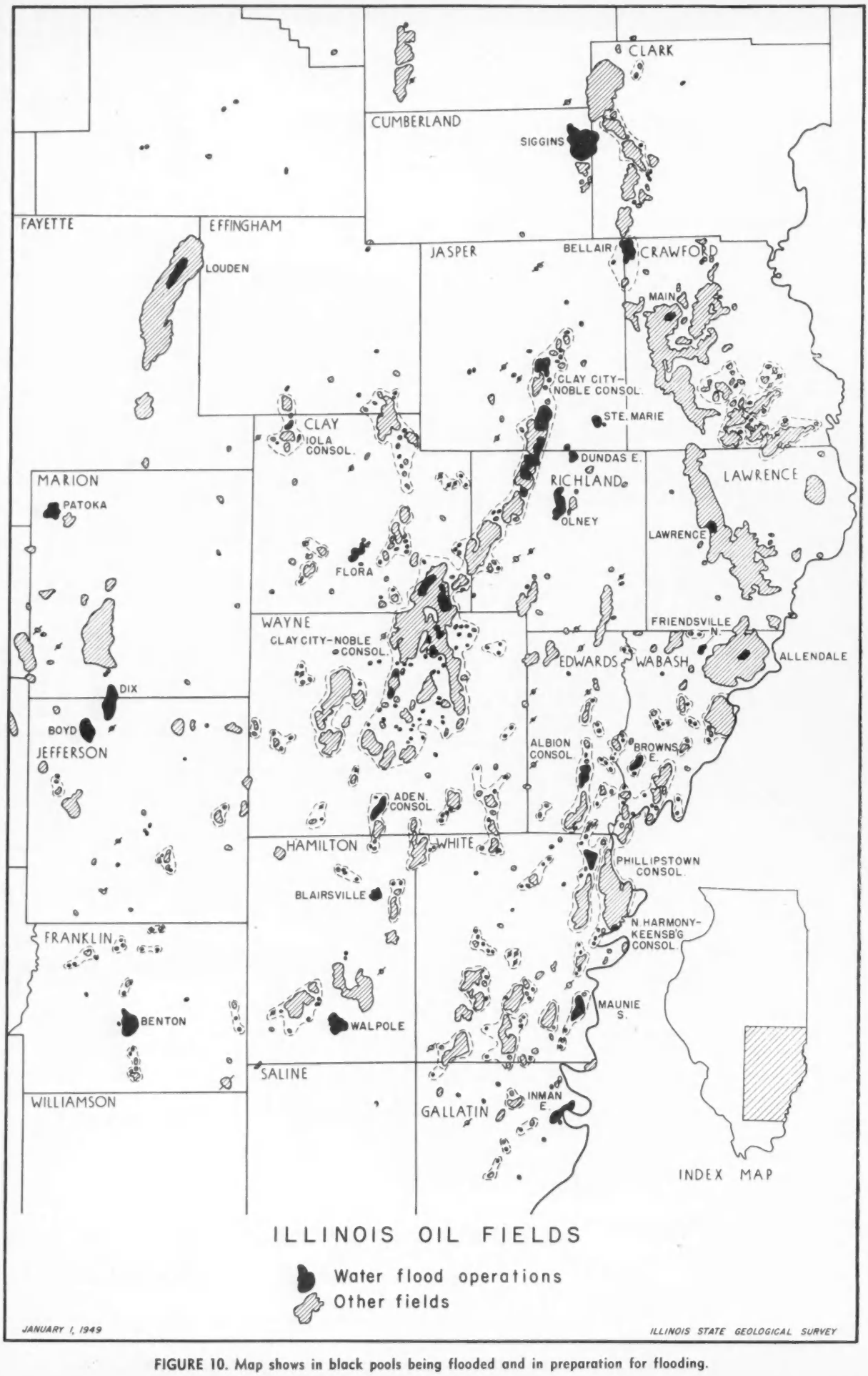


FIGURE 10. Map shows in black pools being flooded and in preparation for flooding.

Measuring Porosity of Oil Field Cores

By

CLEO GRIFFITH RALL
Assistant Chemist, Bureau of Mines

and

D. B. TALIAFERRO
Principal Petroleum Engineer,
Bureau of Mines

FIGURE 1. General view of apparatus used for determining the porosity of oil sands.

☆

THIS ARTICLE IS A CONDENSATION of Bureau of Mines Report of Investigations No. 4548, "A Bureau of Mines Method for Determining Porosity: A List of Porosities of Oil Sands" by the same authors. The Bureau of Mines publication, which represents work done under a cooperative agreement between the Bureau of Mines, U. S. Department of the Interior, and the state of Oklahoma, will contain tables giving the specific volume of mercury at various temperatures and factors for the deviation of air and helium from the ideal gas laws, sample calculations, a bibliography of porosity determination methods, and a list of porosities of oil sands. Copies will be obtainable from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13.

THE method for determining the effective porosity of oil- and gas-bearing sands described in this report is a development of an earlier method[1] devised by Bureau of Mines engineers. The apparatus has been improved and made more convenient to use, but the procedure has been in use for many years without essential changes. The method was devised and developed at the Petroleum Experiment Station at Bartlesville, Okla., as part of the Bureau's research on fluid-energy relationships and on methods of improving the recovery of crude oil from underground reservoirs.

Information regarding the pores or voids in reservoir rocks is vitally important in the scientific extraction of petroleum from natural underground reservoirs, and petroleum technologists concerned with subsurface conditions have devised various methods which give reasonably accurate information as to the porosity of oil- and gas-bearing sands. Several investigators have utilized the experience gained in the ceramic and other industries.

General Scheme

The data needed for calculating the percentage porosity of a test specimen are the volume of the sand grains comprising the specimen and the bulk vol-

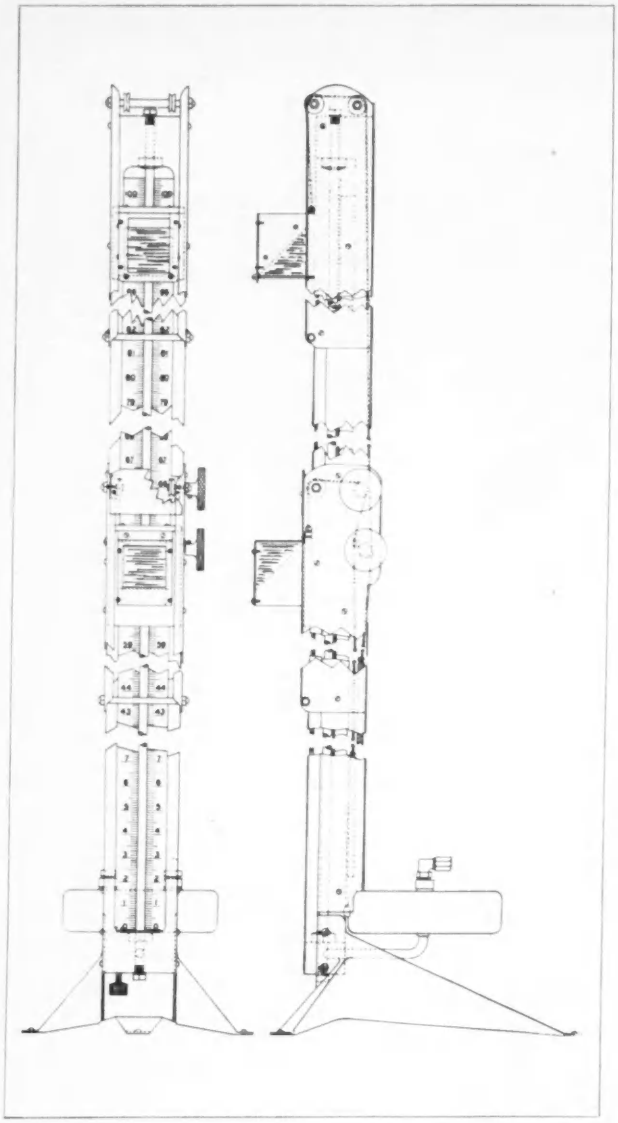


FIGURE 2. Manometer used for pressure measurements, showing periscope.

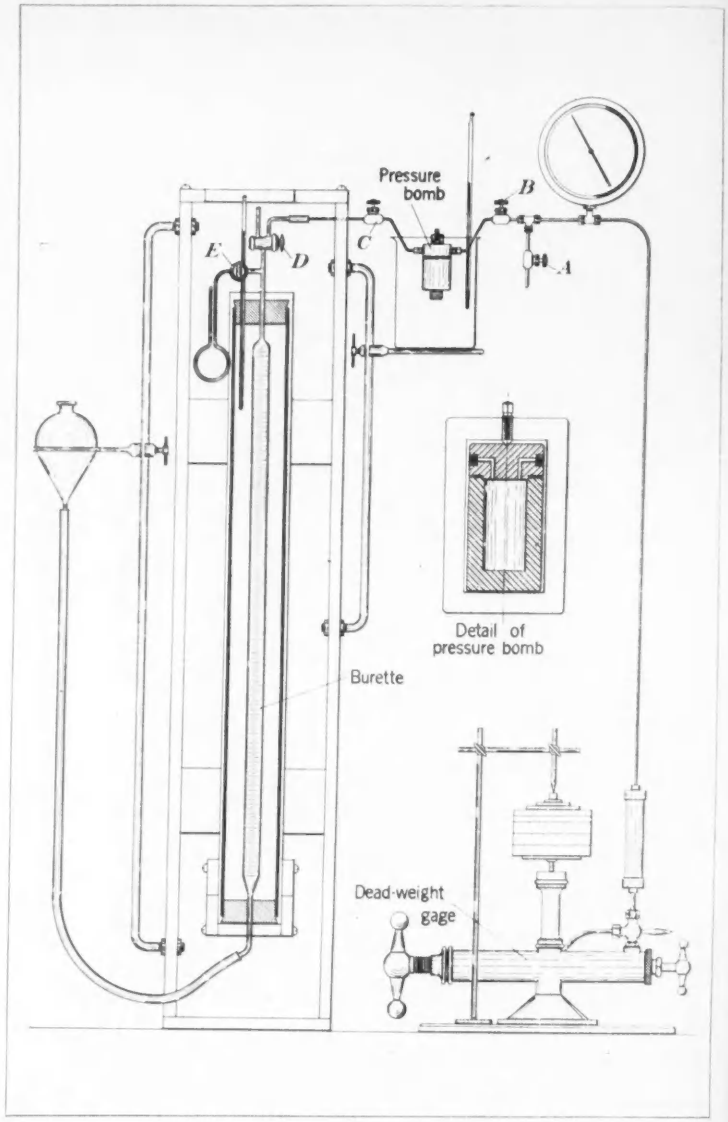


FIGURE 3. Apparatus for porosity determinations using dead-weight gage.

ume of the specimen. (Throughout the discussion of this method it should be understood that the term "porosity" means the "effective porosity" and that the "volume of sand grains" includes the volume of the isolated pores.) After removal of the contained fluids by extraction, the specimen is dried, and the volume of the sand grains is determined by noting the reduction of void space in a vessel or bomb of known capacity when the specimen is placed in it. The void space in the bomb is determined by introducing compressed gas into the bomb, observing the pressure in the bomb, and later releasing the compressed gas and accurately measuring its volume at atmospheric pressure.

Void Space Calculated

With the above data, the volume of the void space in the bomb is calculated by use of the pressure-volume relationship expressed by Boyle's Law, using a correction factor for the deviation of the gas employed from Boyle's Law at the pressure and temperature of the test. When there is a difference in temperature between the compressed gas in the bomb and its expanded volume as measured in the burette, the expanded volume is converted to a volume at the temperature of the gas in the bomb by application of the temperature-volume relationship expressed by Charles' Law.

The capacity of the bomb is determined in the same manner. The difference between the capacity of the bomb and the void space in the bomb with the test specimen in it is the volume of the sand grains.

The total or bulk volume of the specimen is determined with a pycnometer, using mercury. The difference between the bulk volume and the volume of the sand grains is the volume of pore space in the specimen, and this volume divided by the bulk volume and multiplied by 100 is the porosity in percent.

Apparatus

The apparatus (Figure 1) consists of a source of compressed gas, equipment for measuring pressure, a pressure bomb into which the test specimen is placed, and a burette into which the gas is expanded and measured at atmospheric pressure.

A 100-inch mercurial manometer (Figure 2) or a dead-weight gauge (Figure 3) is used for measuring pressure. This manometer is a well-type unit designed for table or floor mounting and is equipped with a return well to prevent the loss of mercury if the capacity of the instrument is exceeded. It has been fitted with two prisms which form a periscope to facilitate reading the mercury levels near the top of the instru-

Free Pumping

LOWERS OPERATING COSTS *66%*

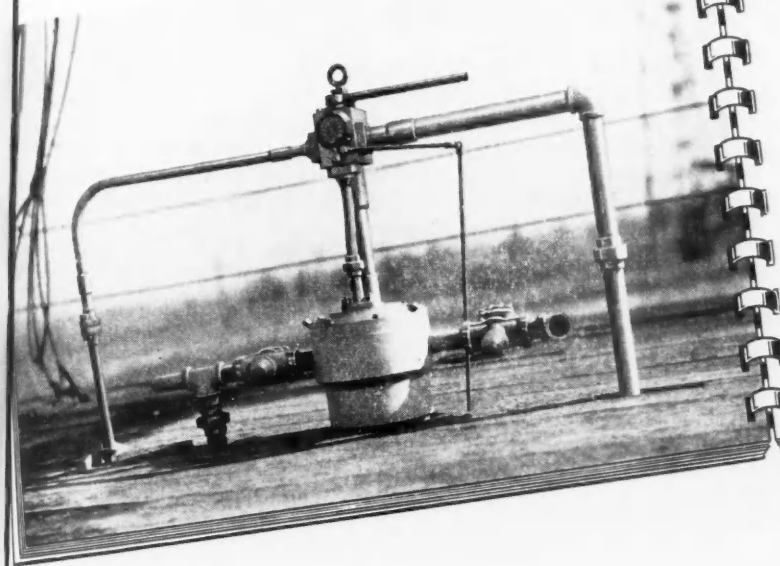
...and that's only half the story*

CASE HISTORY

Well No. 26

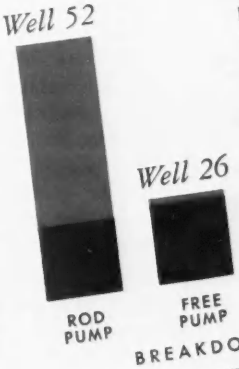
DEPTH 4710'

DOMINGUEZ FIELD, CALIFORNIA



CASE HISTORY

Comparative 4-Year Operating Costs of Two Wells on Same Lease



The detailed operating costs kept on two Dominguez wells over a period of four years (see below), dramatically reflect the savings achieved by Free Pumping. As the chart and figures show, the big difference in operating cost of the two wells is in pump pulling. Total 4-year pulling cost for the rod pump well was $871; for the Free Pump well only $37.

BREAKDOWN OF OPERATING COSTS

	Well No. 26 Free Pump (51 months)	Well No. 52 Rod Pump (50 months)	Well No. 52* Free Pump (7 months)
Depth	4710 ft.	4228 ft.	4228 ft.
Pump Repair Cost (cost/bbl.)	.58c	.53c	.00c
Pump Pulling Cost (cost/bbl.)	.05c	1.30c	.00c
Total Cost (cost/bbl.)	.63c	1.83c	.00c

***The second half of the story** is even more surprising. It starts with the conversion of Well 52, with which Well 26 is compared, to Free Pumping. In seven months since the conversion was made, no expense has been incurred for repairs or pump pulling.

The performance of *Free Pumping* recorded here is not an isolated instance. *Free Pumping* consistently reduces operating costs because it eliminates the high cost of pump pulling and downtime losses. There is no waiting for equipment. No long delays due to weather or road conditions. One man alone can change a bottom hole *Free Pump*.

Paraffin control—another big expense in some fields—is reduced to a routine operation with *Free Pumping*.

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Free Pump

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ment. The lower prism is adjustable between heights of 4½ and 5¾ feet above the floor level by a conveniently located thumbscrew so that the prism may be placed readily at the eye level of the operator. The upper prism is adjustable between 82 and 100 inches on the manometer scale, as most of the pressures used are within this range. This rather elaborate system of adjustable prisms is a convenience but is not an essential part of the apparatus. The need for the prisms might be eliminated by sinking the lower part of the manometer below floor level so as to bring the top of the manometer down to eye level, or by elevating the remainder of the equipment to the level of the top of the manometer and providing a platform on which the operator might work.

Using Manometer

The manometer is connected to the bomb-burette assembly at the tee between valves A and B shown in Figure 3, replacing the dead-weight gauge. In the earlier publication describing this method, it was pointed out that a dead-weight gauge was used for pressure measurements. Although the results obtained with the dead-weight gauge were usually quite satisfactory, trouble was experienced occasionally when air was trapped in the oil system in the gauge. Hence the use of a manometer is recommended when new equipment is to be installed, although replacement of a gauge on equipment already in place is not advocated as essential to obtaining reliable results.

The pressure bomb consists of a steel cylinder 1¾ inches outside diameter by 3¼ inches long (detail, Figure 3); the corresponding inside dimensions are 1 inch by 2⅛ inches. The cover of the bomb fits with a ground joint and is held tightly in place with a clamp. Coating the ground joint with a thin film of stopcock lubricant, carefully applied, aids in securing a gas-tight seal. As explained under the subhead "Reproducibility and Accuracy," it is desirable to have the volume of free space in the bomb equal as nearly as possible the bulk volume of the test specimen. If the specmen is cylindrical, the free space may be reduced by inserting into the bomb a suitable combination of steel disks and collars. If an irregular specimen is used, the reduction in free space may be effected by filling in around the specimen with glass beads, steel balls or other similar material. The collars and disks should be numbered and a record made of those used in each determination, so that whenever the same combinations are used on subsequent tests, the previous determination of the capacity of the bomb may be used. By following this procedure, it soon should be possible to fit almost any cylindrical specimen in the bomb with a combination that has been used before.

Details of the design of the burette used since the dead-weight gauge was replaced by the 100-inch manometer are shown in Figure 4. The design of the burette used with the dead-weight gauge is identical, except that the diameter of the graduated section is increased to provide a capacity of 100 milliliters, as higher pressures are necessary to obtain the maximum sensitivity of the gauge.

Valves A, B, and C (Figure 3) are small brass needle valves, and D and E are glass stopcocks. All connections between the compressed gas supply and Valve B are made with one-fourth-inch copper tubing. The connections from valve B to the bomb, from the bomb to valve C, and from valve C to the burette are made with one-eighth-inch copper tubing. The use of tubing of small bore between valve B and the burette increases the accuracy of the determination by reducing the capacity of the system just as does the use of slugs and collars in the bomb. Both the bomb and the burette are contained in water baths to prevent any rapid change of their temperatures and to facilitate measurement of their temperatures.

Procedure

The first step in obtaining the data required for the calculation of the porosity of a specimen is to measure the capacity of the bomb. The bomb is prepared for this step by inserting steel collars, disks, or other solid material to reduce its capacity as much as possible, considering the dimensions of the specimen. The greatest accuracy in the determination is obtained by using the highest pressure possible considering both the capacity of the pressure-measuring device and the capacity of the burette. When a manometer is used, its capacity usually is the limiting factor.

Helium is used in the determination as it is adsorbed by the reservoir rocks tested to a smaller extent than air or other gases readily available. However, the error resulting from the use of air is small. When helium or any gas other than air is used, all air should be flushed from the bomb, the pores of the sample, and the lines by filling them with the gas used at the maximum operating pressure and exhausting the resulting mixture of gases to the atmosphere before the actual measurements are made.

After an estimate is made of the highest pressure that may be used, Valve C (Figure 3) is closed, Valve B is opened and helium is admitted to the system through Valve A until the manometer or dead-weight gauge indicates approximately the correct pressure. Valve A is closed, the pressure in the system is allowed to come to equilibrium, and the pressure is recorded. The Stopcock D is opened to the atmosphere and the leveling bulb is raised until the mercury level is near the zero mark. The temperatures of the bomb and burette and the position of the mercury level in the burette are recorded. Valve B and Stopcock E are closed, Stopcock D is adjusted to connect the bomb with the burette, and Valve C is opened slowly, allowing the gas enclosed in the bomb to expand into the burette. The pressure in the bomb-burette assembly is brought to atmospheric pressure by adjusting the level of the mercury in the leveling bulb to that in the burette, first roughly, by sighting across the two mercury surfaces, and then precisely, by using the small, butylphthalate-filled manometer which is connected to the burette through Stopcock E. Butylphthalate is used in the manometer because of its low vapor pressure. Other fluids of higher vapor pressure might have some adverse effect on the accuracy of the determination during hot weather. The use of a leveling-bulb support with thumbscrew adjustment aids in the final adjustment of the leveling bulb. The mercury level in the burette and the barometric pressure then are recorded. With these data, the capacity of the pressure bomb is calculated.

The second step is to place the test specimen in the bomb and measure the volume of the void space remaining in the bomb by repeating the foregoing procedure. This volume includes both the pore space in the specimen and the space in the bomb not occupied by the specimen.

Third Step

The third step is to determine the bulk volume of the specimen by weighing the mercury which it displaces from a pycnometer. A stainless steel pycnometer of the type shown in Figure 4 has been found particularly suited for this measurement. The pycnometer is filled with clean mercury, and the stopper is pressed firmly into place, causing the excess mercury to overflow. The mercury in the hole in the stopper is wiped off flush with the surface of the stopper, and any particles of mercury clinging to the pycnometer are brushed off with a camel's-hair brush. The pycnometer then is placed in a clean enameled pan, the stopper removed and the specimen pushed under the surface of the mercury by means of the prongs on the stopper. Complete submersion of the specimen in the mercury by the prongs prevents the formation of an air bubble under the stopper. Errors in the determination due to entrapped air are not uncommon if the specimen and the stopper are in direct contact. The stopper is pressed firmly into the pycnometer, the pycnometer is brushed clean,

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2. Lower Casing Head and Slip Test Weld "Boll Weevil" Casing Hanger, Type "A2," Gray Patent No. 2,207,-469.
3. Lower Casing Head and Rolled "Boll Weevil" Casing Hanger, Type "A3," Gray Patent Pending.

Patents

4. Lower Casing Head and Control Type "Boll Weevil" Casing Hanger, Type "A4," Gray Patent No. 2,485,497.
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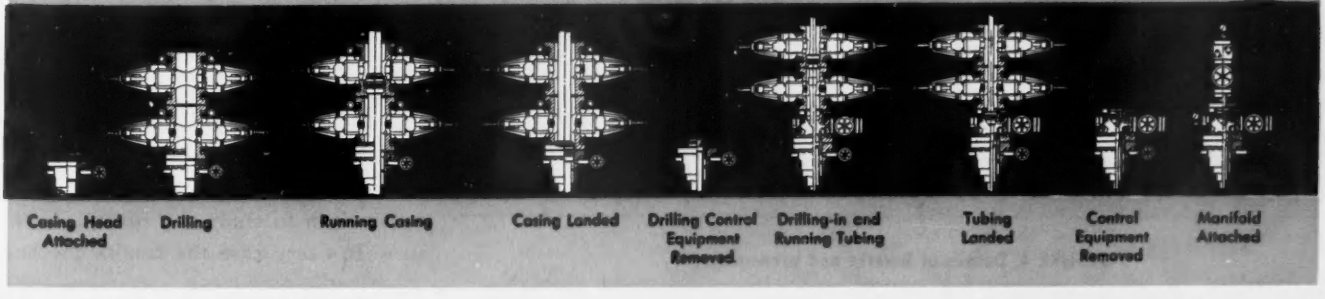


as before, and the displaced mercury is carefully transferred to a small, weighed beaker or other suitable container and weighed to the nearest decigram. The temperature of the mercury is measured and recorded. The bulk volume of the specimen is obtained by multiplying the weight of the displaced mercury, in grams, by its specific volume at the temperature of the test.

Calculations

The calculation of the capacity of the bomb is based on the pressure-volume-temperature relationship for gases expressed by the ideal gas laws, or

$$\frac{P_B V_B}{T_B} = \frac{P_b V_1}{T_1} \qquad (1)$$

where

P_B = absolute pressure of the gas in the bomb,
T_B = absolute temperature of the gas in the bomb,
V_B = capacity of the bomb,
P_b = absolute pressure of the gas in the burette (also pressure of the gas in the bomb after expansion of the gas),
T_1 = absolute temperature of the gas after expansion, and
V_1 = total volume of the gas after expansion.

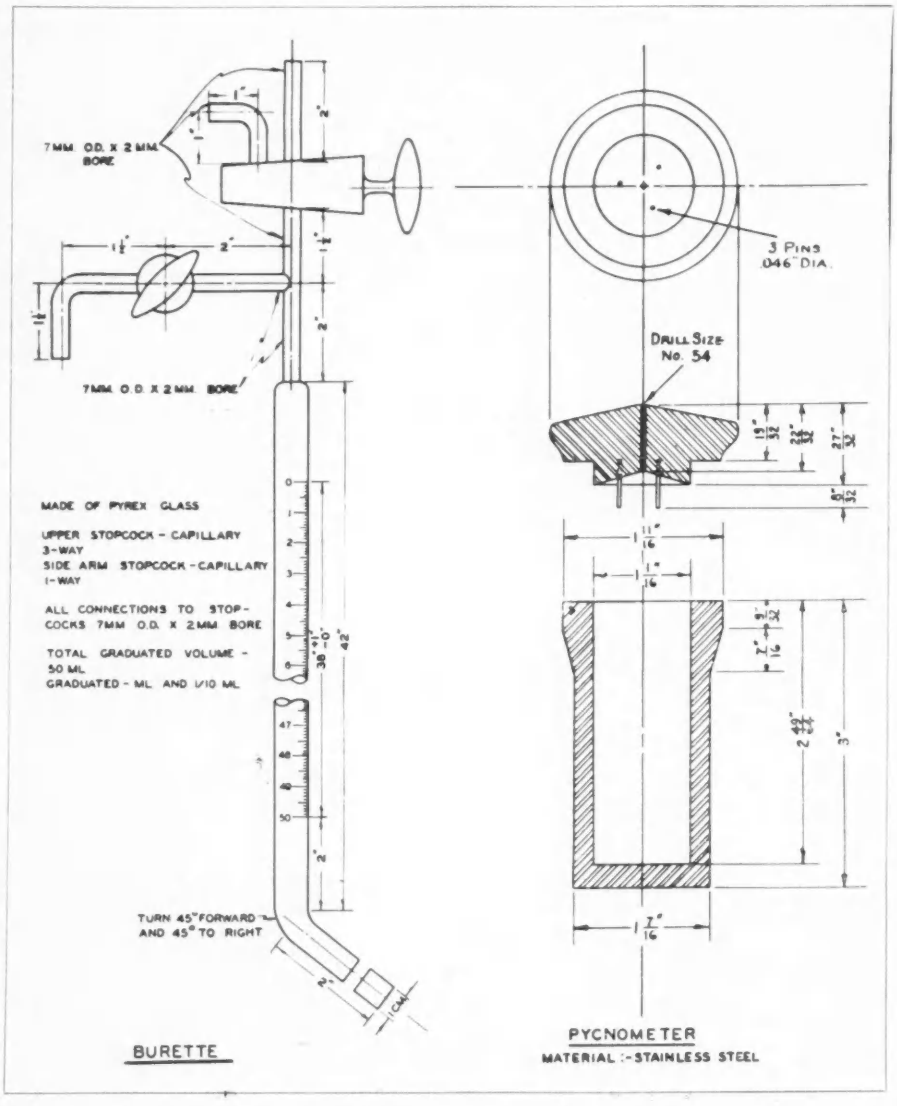
The total volume of gas after expansion is equal to the volume of gas measured in the burette plus the volume of gas remaining in the bomb, or

$$\frac{P_b V_1}{T_1} = \frac{P_b V_b}{T_b} + \frac{P_b V_B}{T_B} \qquad (2)$$

where

V_b = volume of gas measured in the burette,
T_b = absolute temperature of gas measured in the burette, and other symbols as previously defined.

The volume of gas between valve C and the mercury level in the burette, as well as that above the fluid in the butylphthalate manometer, remains constant at atmospheric pressure throughout the determination. Hence, it may be neglected in calculations.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7MM O.D. X 2 MM. BORE
3 PINS .046" DIA.
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MADE OF PYREX GLASS
UPPER STOPCOCK - CAPILLARY 3-WAY
SIDE ARM STOPCOCK - CAPILLARY 1-WAY
ALL CONNECTIONS TO STOPCOCKS 7MM O.D. X 2MM BORE
TOTAL GRADUATED VOLUME - 50 ML
GRADUATED - ML AND 1/10 ML
TURN 45° FORWARD AND 45° TO RIGHT
BURETTE
PYCNOMETER
MATERIAL :- STAINLESS STEEL

FIGURE 4. Details of burette and pycnometer.

Substituting this value of $\frac{P_b V_1}{T_1}$ in equation 1,

$$\frac{P_B V_B}{T_B} = \frac{P_b V_b}{T_b} + \frac{P_b V_B}{T_B} \qquad (3)$$

Many common gases conform approximately to Boyle's Law at ordinary ranges of pressure and temperature, but no real gas follows it exactly. Some of the porosity determinations described in this report were made with dry compressed air whereas others were made with helium. Within the ranges of pressure and temperature used in these experiments, air with an increase in pressure is more compressible; and, conversely, with a decrease in pressure it is more expansible than the ideal gas. Under the same conditions, helium is less compressible with increase in pressure and less expansible with decrease in pressure than the ideal gas. To obtain the true value of pressure times volume ($P_s V_s$) at the standard pressure (P_s), the product of the pressure times volume at a given, or initial, condition, $P_x V_x$, is multiplied by a correction factor y, which, under the conditions of pressure and temperature of these experiments, is greater than 1.0 for air and less than 1.0 for helium. When a correction factor for the deviation from Boyle's law is applied, equation 3 becomes,

$$y\frac{P_B V_B}{T_B} = \frac{P_b V_b}{T_b} + \frac{P_b V_B}{T_B} \qquad (4)$$

where y is the deviation factor at pressure P_B, letting the value of y at P_b equal 1.0, from which

$$V_B \frac{yP_B - P_b}{T_B} = \frac{P_b V_b}{T_b} \qquad (5)$$

and

$$V_B = \frac{T_B}{T_b} \times V_b \div \left(\frac{P_B y}{P_b} - 1\right) \qquad (6)$$

The above formulas are likewise applicable in determining the void space in the bomb with the specimen in it. The term V_B then is defined as the volume of void space in the bomb with the specimen in it instead of the capacity of the bomb.

Reproducibility and Accuracy

The sources of error in determining porosity by this method comprise those in measuring pressure, volume, and temperature. The effect of a given error in any of these measurements depends on the particular conditions of the test.

The porosities of several specimens have been determined using a range of pressure from 40 to 250 pounds per square inch to study the effect of pressure. In every case the results checked

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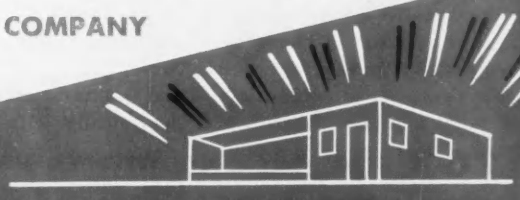

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very closely, indicating that neither the bomb nor the test specimen was affected appreciably by the pressure used.

The use of disks, collars, and slugs in the bomb to reduce the space in it unoccupied by the specimen results in a greater accuracy which is due in part to the fact that a higher pressure may be used in the bomb without exceeding the capacity of the burette when the volume of the gas is measured at atmospheric pressure. This is particularly true when using the deadweight gauge, which is more sensitive at higher pressures. Also, at higher pressures, an error of one-tenth or two-tenths pound means a smaller percentage error in the pressure measurement. With the use of a manometer, the pressure, of course, can be measured with a higher degree of accuracy. Furthermore, it is desirable to reduce the volume of unoccupied space in the pressure bomb, because the volume of the sand grains in the sample is not measured directly but is equal to the difference between the volume of the bomb and the volume of void space remaining in the bomb when the core is placed in it. The percentage error in either of these two volumes is greatly magnified in their difference, and the magnification will vary directly as the two volumes. In other words, if the volume of the void space remaining in the bomb when a specimen is placed in it is twice as great as when the specimen is placed in another bomb, a given percentage error in the determination of the volume of void space remaining in the bomb would result in twice as great an error in the porosity.

Effect of Error

When a burette of good quality is used and care is taken in the readings, the error in any reading should not exceed ±0.02 milliliter. The effect of a given error in the volume, as measured in the burette, depends upon the magnitude of the volume measured and the magnitude of the pressure used. If air is expanded from a pressure of ten atmospheres, a given error in reading the volume affects the porosity value approximately half as much as if it had been expanded from only five atmospheres.

With good thermometers, the temperatures should be measured easily to 0.5° F. When a ten-milliliter sample is used, a variation of ±0.5° F. in the temperature reading causes a variation of about 0.1 percent in the porosity value. Such an error is within the limits of experimental accuracy.

Certain percautions should be observed in the determination of the volume of the sand grains to eliminate possible errors due to the manipulation of the apparatus. Before an initial test with the apparatus is made, Stopcock E (Figure 1) should be opened to the burette and Stopcock D turned to open the burette to the atmosphere, to bring the manometer into balance. This should not be necessary on subsequent tests, as the manometer is balanced at the conclusion of each test. If the room temperature is high, and water is used in the manometer, the vapor pressure of the water may throw the manometer out of balance during the course of a test. This is avoided by using a fluid having a low vapor pressure. Dibutylphthalate has been found satisfactory for this purpose, as its density is low and its vapor pressure is even less than that of mercury. Leaks are an ever-present source of error; therefore, all fittings and joints should be tested for leaks periodically with a soap solution.

Washburn and Bunting[2] pointed out that with ceramic bodies some gases are adsorbed and therefore higher porosities are indicated by gas-expansion methods than actually exist. Dry air, although adsorbed to a certain extent by some materials, has been used, as it is the most convenient gas for the determination of porosity in the average laboratory. To determine the magnitude of the error due to adsorption when air is used, a number of porosity measurements made with air were duplicated with helium. The adsorption of this gas by most materials at room temperature is negligible. In every case the porosity obtained with air was larger, but the difference in the two values was not excessive. Therefore, it is believed that dry air should be satisfactory for most work. However, if extremely accurate results are desired, helium or hydrogen should be used. If hydrogen is chosen as the gas for use with this method, the danger of producing an explosive mixture of hydrogen and air should be considered and safety precautions taken.

The greatest inaccuracy in the method is in the determination of the bulk volume of the specimen. Check determinations have been made on more than 2000 test specimens, and on nearly all of these, the results of the bulk volume determination varied by less than 0.2 percent.

If the test specimen is allowed to touch the lid before all the air is expelled from the pycnometer, a bubble of air remains in the pycnometer and causes an error of 3/100 or 4/100 of a milliliter. This source of error has been eliminated by using the special type pycnometer with prongs to submerge the sample below the surface of the mercury as described herein. The pycnometer should be handled as little as possible to avoid any appreciable change in the temperature of the mercury during a determination. With reasonable care the temperature of the mercury does not change more than 2° F. during a determination, even under unfavorable weather conditions. This means a change of only 0.02 percent in the specific volume of mercury.

If the pores on the surface of the test specimen are large enough to allow mercury to enter them, the core should be rendered impervious to mercury before it is placed in the pycnometer. Saturating the specimen with some liquid such as tetrachloroethane has been found satisfactory for this purpose. However, it should be remembered that the vapors of this compound are toxic and that it should be used only in a well-ventilated hood. Also, sealing the surface openings by dipping the specimen in fuming-hot paraffin is an effective means of preventing entrance of mercury into the pores. The results of laboratory tests prove that any variation in the bulk volume of a sample caused by as many as three paraffin coatings is within the limits of accuracy of the determination.

The magnitude of the total probable error in a porosity determination depends on the size of the specimen, but, as the several possible errors may be compensative, their over-all effect probably is less than their sum. It is believed that when a test specimen is used having a displacement of eight or ten milliliters, the total probable error in the porosity values does not exceed ±0.25 percent. If a specimen having a displacement of three or four milliliters is used, the total error in porosity value probably is twice as great; and, conversely, if a larger specimen is used, the probable error is less.

Advantages of the Method

Probably the greatest advantage of the method is that the test specimen is not affected in any way by the determination and is available for other tests (unless it has been necessary to paraffin-coat the specimen for the bulk volume determination); or, if it is desired, check porosity determinations may be made.

Very accurate results may be obtained, and yet the time required for a determination is not excessive. If the capacity of the bomb is known from previous tests, the determination of the volume of the sand grains can be made in five to ten minutes. The determination of the bulk volume of the core by the displacement of mercury requires about the same length of time. When a number of cores are tested, 15 minutes should be sufficient for each.

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By GILBERT M. WILSON
Pacific Coast District Editor

FIGURE 1. Conventional, fingerboard-equipped portable pulling unit is used for pulling wells in economical manner described. Rods are stood up beside tubing, on side nearest the well. Wells in this area are from 2100-2300 feet deep.

TIME AND LABOR can be saved and equipment protected against possible damage by adoption of the changes from normal procedures outlined by the author in this article. Slight modifications to automotive equipment and provision of special racking bases help speed work and reduce time lost while well is being serviced.

ONE of the largest single items of expense incurred in the operation of a producing lease is well pulling. Any means that can be developed to shorten the time required to pull a well therefore is extremely desirable, and it is well worth the while of the production department to adopt practices or equipment that will help reduce these expenses. Any saving made in the pulling of a well generally is of two-fold importance. First, by reducing pulling time, less expense is charged to the particular well or lease; and second, minimum production is lost as a result of the reduced down-time.

In some instances, to be sure, production lost during the time the well is down may be made up afterward, but in many cases such lost production remains lost. In the case of high-cut wells, such loss of production may continue until the accumulated head of water again has been pumped down.

The crews of one producing company have effected this two-fold type of saving by adopting work- and time-saving techniques du ing rod- and tubing-pulling jobs. Using a conventional truck-mounted production type unit (Figure 1) equipped with fingerboards to pull rods and tubing in singles, it was found that savings could be realized by (1) breaking out rods with the box down instead of up; (2) standing the rods on the floor instead of hanging them up in the derrick; and (3) exercising more care in the racking of tubing. In the particular instance referred to, conventional type, Range 2, three-fourth-inch sucker rods and 2½-inch externally upset Range 2 tubing were used.

It is possible to break out sucker rods with boxes either up or down. However, if they are pulled so the box remains up, wind-borne dust and debris settling in the vicinity will accumulate in the box, making thread cleaning and re-running of the rods more time-consuming, particularly if several days should elapse between the time rods are pulled and the well put back on. By pulling them with the box down, such accumulation of debris cannot occur. Some crews report, also, that wrenching is easier with boxes down.

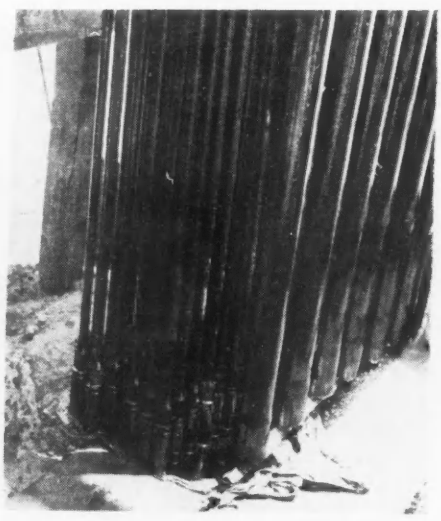

FIGURE 2. Sucker rods, pulled with boxes down, are stood on floor in as nearly vertical position as possible, and in moderate-sized groups. Rods are three fourths-inch, Range 2. Cloth or burlap spread on floor prevents floor dirt from entering boxes.

Another time-saving practice consists of standing the rods on the derrick floor, instead of hanging them up in the derrick. While not commonly done, the practice of standing up rods, limber as they are, is accomplished easily if care is taken in racking them, and not too many are racked in a single group. They should be stood up as nearly vertically as possible. In this particular instance, and as illustrated in Figure 2, the rods were racked in two groups, one on either side of the well or walkway.

Depth of the wells in this area being between 2100 and 2300 feet deep, and the pump hung perhaps 100 feet off bottom, this method of racking called for the placing of rods in groups of about five or six wide by six deep, or about 1000 to 1100 feet of rods in each group. A clean rag or piece of burlap is spread out on the floor area and the rods stood on it in order to keep boxes as clean as possible while bailing and other work progressed.

Tubing Stood on Wood Strips

Tubing, pulled in singles also, is racked in the conventional manner with collars up. The string is divided, similar to the sucker rods, so that one-half of it is racked on either side of the walk. In this case, it is racked seven wide and about five deep. In order to protect the threaded ends on the floor from dirt and debris, short strips of wood, an inch or two

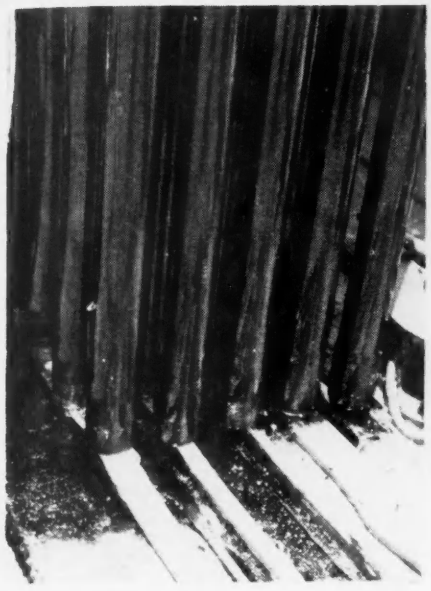

FIGURE 3. Tubing is racked on one- to two-inch strips of soft wood. This reduces possibility of dust or sand getting on threads, and allows the joint to drain thoroughly while work progresses on the well.

wide, are laid down and the joints stood on them. This practice keeps the threads out of the dirt, sand bailings and other material that usually accumulates on the floor during a pulling job, and also allows the joints to drain while racked. Standing the joint on a strip of soft wood in the manner shown in Figure 3 also eliminates possible damage to the first thread; such damage sometimes occurring if the joint should be set down hard on a piece of iron or hard material lying on the floor.

Since the adoption of these time- and labor-saving practices, an appreciable saving in operating costs has been realized. It is estimated that a 50 percent saving in time has been made in running the rods. In either pulling or running-in, rods are run at the rate of about one a minute. The hoist can be operated fast, without waiting for rods to be picked up, and there is little or no lost motion on the part of the men. The floor man, for example, takes only one step in swinging around to pick up or set down a rod. Little or no time is wasted in cleaning threads of either tubing or rods due to the preparations made before pulling to keep threads clean.

Compared to other methods of pulling rods and tubing in singles, such as when they are tailed-out to be laid down on a rack or pair of horses, the present system not only is faster, but requires much less work on the part of the floor men. Outside of the fact that a pulling unit equipped with fingerboards is required to permit standing up rods and tubing, no special equipment or tools are required to accomplish the savings in equipment- and man-hours. The same principles can be applied to any pulling job where wells are of moderate depth.

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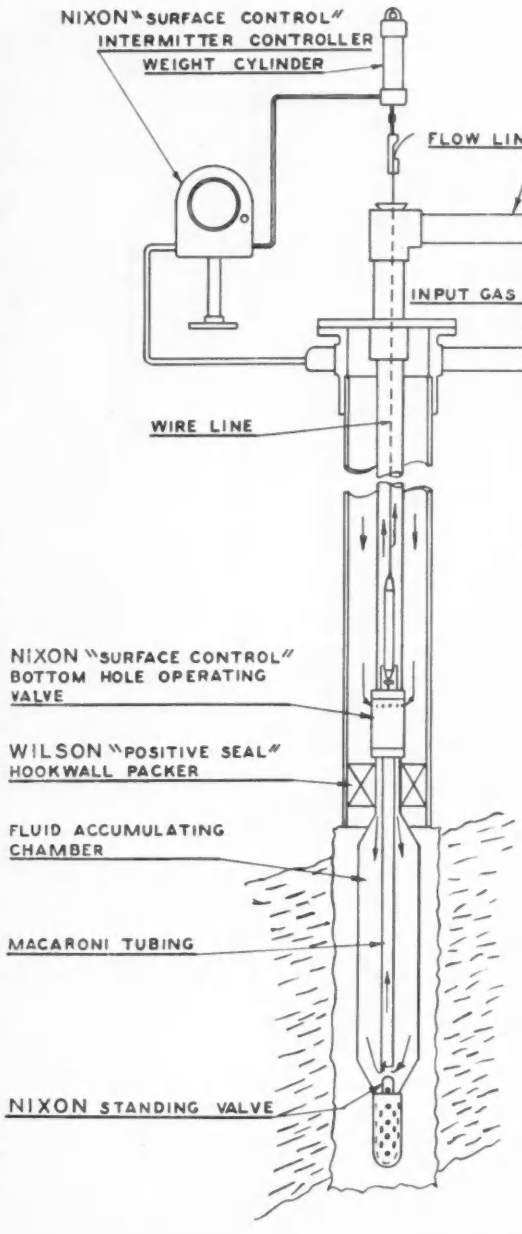

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Was in continuous operation during this period.

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Well produced at rate of 11 barrels per day for about five years; since then has produced at rate of approximately 6 barrels per day.

Total production amounted to over 30,000 barrels during this period.

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Down-Hole Chemical Treatment To Clean *Clogged Formations*

A METHOD for removing paraffin, gyp, and other clogging agents from the face of the pay formation in shot holes at the bottom of oil and gas wells has been applied near Hominy, Okla. All wells treated show increases in production in varying amounts. Generally, the method consists of introducing certain chemicals into the shot hole, which in turn react to create heat and thus melt and/or dissolve the clogging agents which are later bailed out or flowed.

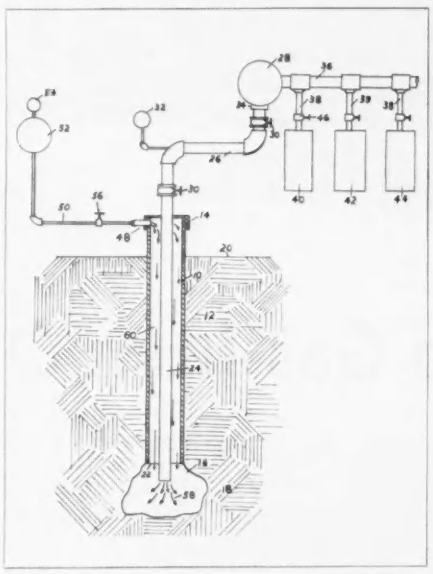
The method was evolved by Virgil D. Lawmaster of Hominy, who recently was granted a patent described as "relating to a method of treating oil and gas or disposal wells for the purpose of removing paraffin, limestone and other deposits from the formation or pay so that the productivity of the well may be appreciably increased."

The method is also designed to increase water injection in secondary recovery operations; to provide a method wherein the reactions between the chemicals will continue in the pay and drive their way further into the formation until new oil is reached; to provide a method to introduce chemicals into the well by air pressure, thus helping to break down the pay formation, and to exert a force which will permit the chemicals to penetrate into the formation.

Equipment needed to apply the new process consists of a tank-mounted truck with auxiliary pumps for injecting the chemicals into the well and a compressor to maintain air pressure at the bottom of the hole after the chemicals have been introduced.

The process requires the sequential addition of a number of chemicals; first, an alkali-metal hydroxide which may be added in solid form or in capsules, but preferably as an aqueous solution. When this relatively strong solution of an alkali-metal hydroxide is introduced into the pay formation, heat of solution is generated to melt the paraffin in the formation.

Following the introduction of the alkali-metal hydroxide, a concentrated aqueous solution of a suitable mineral acid is then added. This will react rapidly with the alkali-metal hydroxide in the well to produce heat of neutralization. In order to overcome the corrosive effect of concentrated acid the operator introduces sulphurized quinoidine as an inhibitor. The total quantity of acid added is greater than the stoichiometric amount required to neutralize completely the previously injected alkali-metal hydroxide. This is to provide an excess of acid in the hole which will react with and dissolve limestone and produce carbon dioxide, and because of the positive pressure employed in introducing the chemicals, the acid, together with the carbon dioxide, will be forced into the pay formation for deeper penetration.

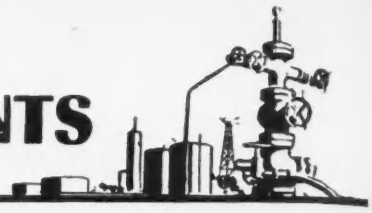


Diagrammatic view of the apparatus. The valves (30 and 46) are operated and the pump (28) started so that the alkali-metal hydroxide solution contained in tank (4) will be pumped through tubing (24) into the bottom of the hole (16) as indicated by the arrows (58). Immediately thereafter compressor (52) is started and valve (56) adjusted so that air under controlled pressure will flow through the casing as indicated by the arrows (60) to keep the alkali-metal hydroxide at the bottom of the hole. The first concentrated mineral acid-inhibitor solution retained in the tank (42) is then introduced into the hole followed by the inorganic carbonate solution in tank (44) and the second mineral acid solution. The rate at which chemicals are fed through the tubing is controlled by valves (30 and 46) and the air pressure within the casing by valve (56). Pressure gauges (32 and 54) enable the operator to control casing and tubing pressures.

Following the addition of acid and inhibitor, an inorganic carbonate in water is added to the well. Following this, another concentrated mineral acid is introduced into the well to react with the inorganic carbonate to produce further carbon dioxide for greater penetration of the pay formation. As in the case of the first acid, the second is added in excess of the stoichiometric amount required to completely react with the inorganic carbonate so that excess acid will remain to continue to attack limestone and clogging deposits. To combat the corrosive action of the second mineral acid, a coating compound is added to the inorganic carbonate solution to form an emulsion. This compound, which coats the bottom of the tubing or casing, is designed to prevent attack by the subsequently added mineral acid. While the second mineral acid may be added first and the inorganic carbonate afterward, or vice versa, it is essential to successful application that positive pressure be applied for the introduction of the inorganic carbonate and the mineral acid so as to keep the latter constantly penetrating the pay formation.

The introduction of chemicals into oil and gas wells to remove paraffin, gyp and other clogging agents is not new, but claimed as new for the above technique are (1) maintaining a positive pressure, with air, in the well to keep the reactants on the pay with no dilution of the chemicals from loading with water or oil; (2) placing alkali-metal hydroxide in the well; (3) using concentrated mineral acid; (4) introducing sulfurized quinoidine as the corrosion inhibitor; (5) providing a coating compound to protect the bottom of the casing and tubing; and (6) using a second concentrated mineral acid and inorganic carbonate.

PRODUCTION HINTS



$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas

HOW TO—Counterbalance Expansion Loops

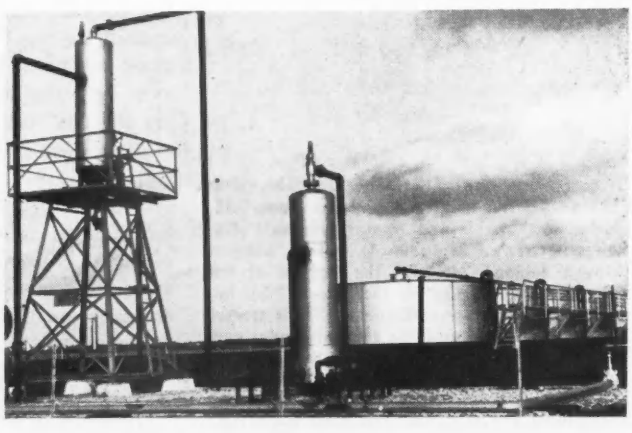
High-pressure gas wells have been equipped with expansion loops on the heavy-duty flow lines to compensate for contraction and expansion of the line due to extreme temperature changes. By permitting the line to expand freely, the danger of breaking a fitting or a flange seal is thereby lessened.

Illustrated is an effective yet simple method of supporting one end of an expansion loop and at the same time providing sufficient freedom of movement in the line. It is a counterbalancing device made of four- and two-inch pipe.

A concrete foundation was poured to provide adequate footing for the two supporting legs. These legs, of two-inch line, were welded in the shape of a long "U" with just enough space separating them so the four-inch horizontal arm could be hinged between them with a heavy steel rod. The rod was held in place by cotter pins.

Weight of the expansion loop was counterbalanced by a pot of hardened cement poured into a short section of 9⅝-inch casing. A connecting arm with an eye held the cement weight to the long distance arm by means of a link. A similar link welded to the shorter arm was attached to the expansion loop through a double-eye rod bolted to the loop by a pipe clamp. No maintenance is required, and if the loop is to be removed from the well head, little time is taken to disconnect it from the counterbalance.

HOW TO—Separate Gas from Oil at Tanks



When the separated gas from a field is supplied to a natural gasoline plant, it is desirable to get from the oil as much of the lighter fractions into the gaseous phase as possible. This can best be done in the field by reducing to a minimum the pressure at which the gas is separated from the oil.

Wells flowing under reservoir pressure or reduced pressures normally serve to force the oil through the flow lines into the separators, where sufficient back pressure is maintained to flow the liquids into treaters or directly into the lease stock tanks. The problem lies in reducing the back pressure at the separator to a minimum while maintaining sufficient head pressure to flow the liquids into storage.

Illustrated is a tank battery layout that accomplishes this purpose with a back pressure on the elevated separator (shown at left) of 0 to 5 pounds per square inch. Pressure necessary to flow the oil into stock tanks is obtained by elevating the separator about 12 feet so that the liquids will flow by gravity, plus the separator back pressure, into the stock tanks.

Fluid production from lease wells flows through lines into a manifold near the test separator at right foreground. This separator is used only for testing a well. Oil flows into the elevated separator where a reduction in pressure is accomplished and gas breaks out. At this lowered pressure, a maximum of light fractions will go into the gaseous phase for transfer to the gasoline plant. By elevating the separator for gravity flow into the stock tanks, and by holding practically no back pressure during the separation, considerably more gas is obtained than otherwise would be separated with 25-30 pounds back pressure.

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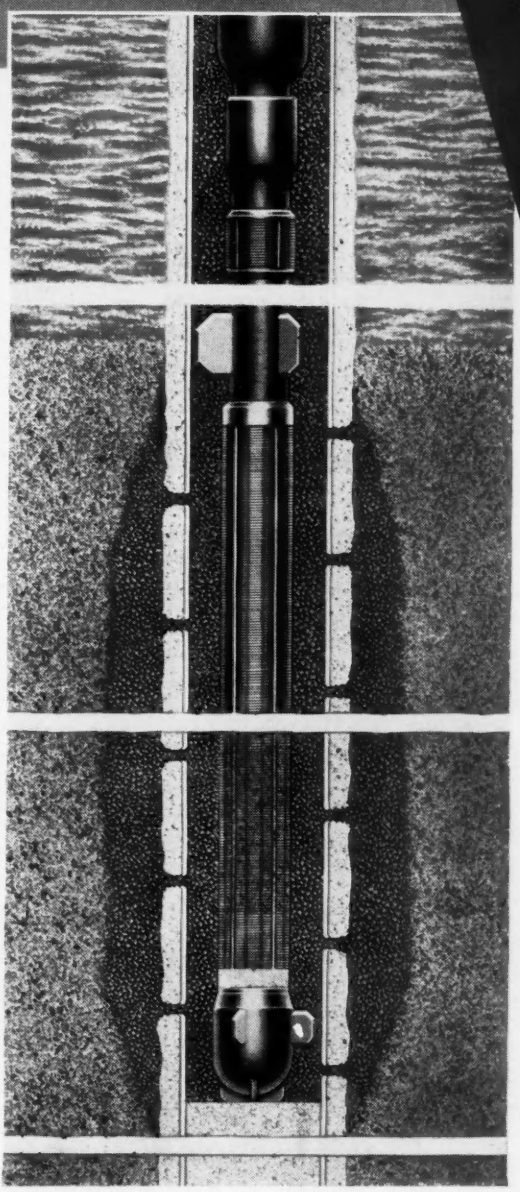

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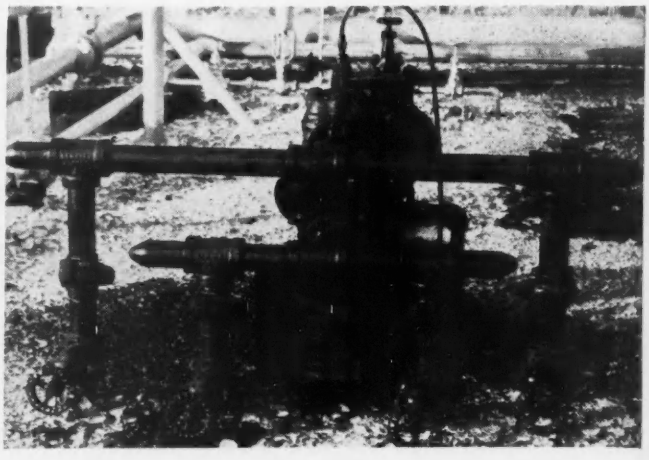
HOW TO—Use Tank Battery Pump



One of the primary functions of the tank battery circulating pump is to move oil in the lease tanks or roll the contents of the tank for cleaning. Additional uses of the circulating pump can be obtained by installing a dual manifold on the suction and on the discharge.

Illustrated is a circulating pump that handles fluid in the tanks, and is connected to pick up oil from inside the firewall and pump it to a heater-treater for salvage. The pump can perform other jobs as well.

The suction manifold has one connection to the burning pit; a second suction line is connected to each lease stock tank and the battery sump inside the firewall, and to the separators. On the discharge manifold, one line leads to the heater-treater, while the second connects to the burning pit.

Such a simple combination permits rolling of the lease tanks, transfer of oil from one tank to another, running salvaged oil from the firewall sump through the heater-treater, pumping bad oil into the burning pit, or picking up oil from burning pit and treating it for storage.

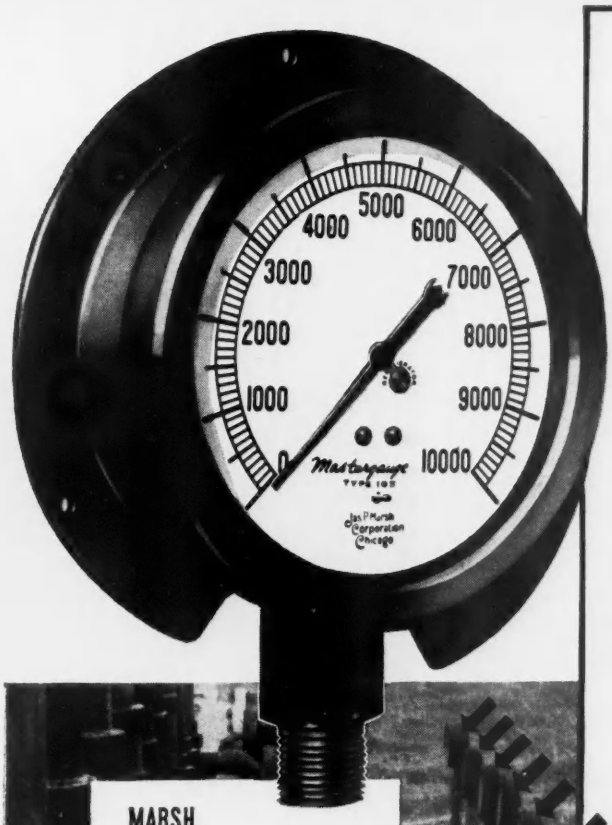
Thus, through the installation of dual manifolds and additional lines, the lease tank battery circulating pump has been been made to double its functions.

HOW TO—Pipe Heater-Treater Gas

When the production from several wells flows directly into a heater-treater, the gas which is separated can be handled through several different lines. In the case illustrated, as much gas as possible was piped to a nearby gasoline plant where liquid fractions were removed.

The black line entering at right foreground takes gas from the heater-treater gas accumulator. Between 25 and 30 pounds per square inch back pressure is held on the treater so the clean oil will be forced into the lease stock tanks. An elevated pop valve serves to protect the heater-treater shell from excessive pressures, and it opens when the pressure exceeds the safe working pressure of the heater vessel.

Gas from the treater can be flowed either directly into the gasoline plant line or into the separator where additional fluid is dropped out at from 0 to 5 pounds back pressure. Another four-inch line connects the gas outlet to a pressure relief line where excessive line pressures can be popped off. A four-inch line from the low-pressure separator also dumps gas into the gasoline plant line on which a very low pressure is maintained to keep all liquids in the vapor phase.



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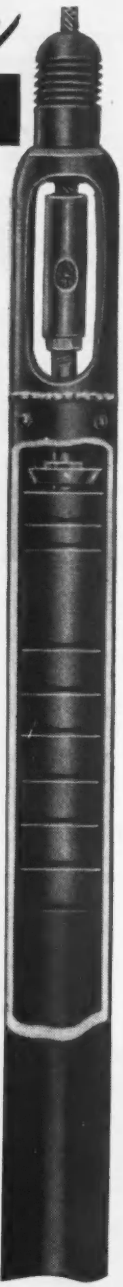

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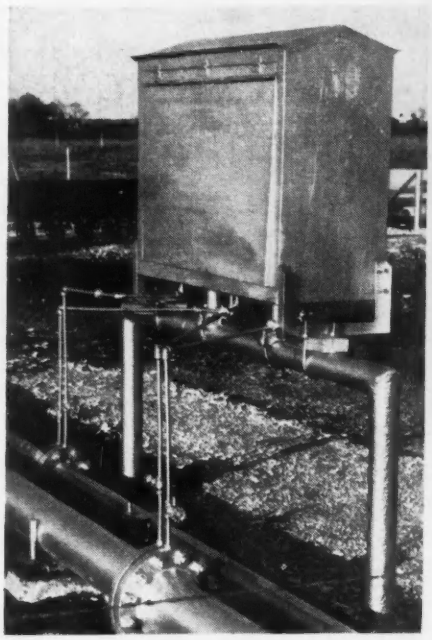
HOW TO—Make Setting for Meters

Where it is necessary to measure the volumes of natural gas to a natural gasoline plant, and gas supplied back to the lease from the plant, a simplified meter setting can be made for both meters. In the illustration, large volumes of natural gas are supplied to a natural gasoline plant nearby and accurate measurement of both gas supplies must be made. Instead of separating the meters on each line and mounting them independently, a common meter support was set up to accommodate both orifice meters.



Orifice plate flanges were inserted in both lines as shown so that they are about four feet apart. A three-inch pipe support welded in the form of a wide "U" and set in concrete about two feet from the smaller line served as the meter mount. Both meters were mounted in the conventional manner by U-bolts fastened around the horizontal support. A frame made of angle iron was attached to the support by U-bolts as shown. This

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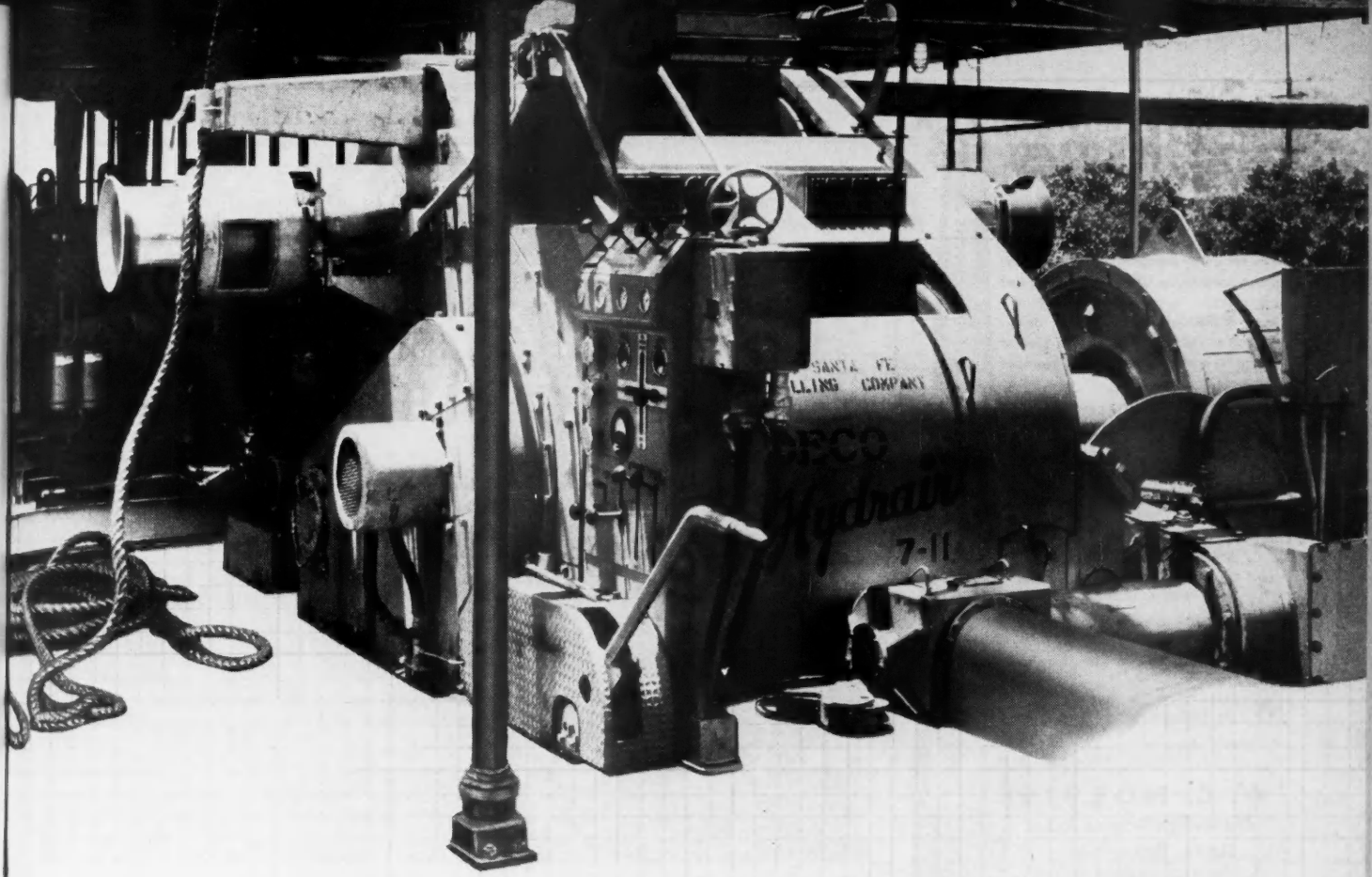

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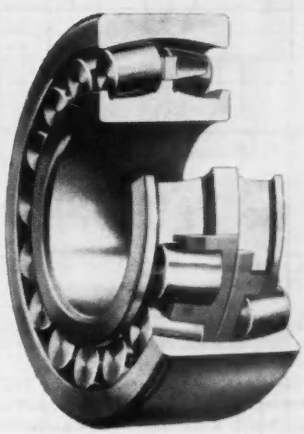

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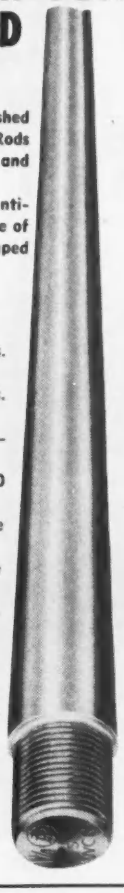

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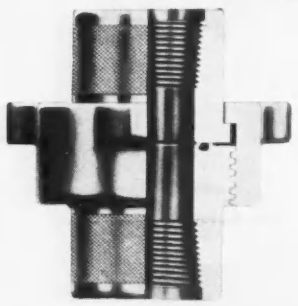

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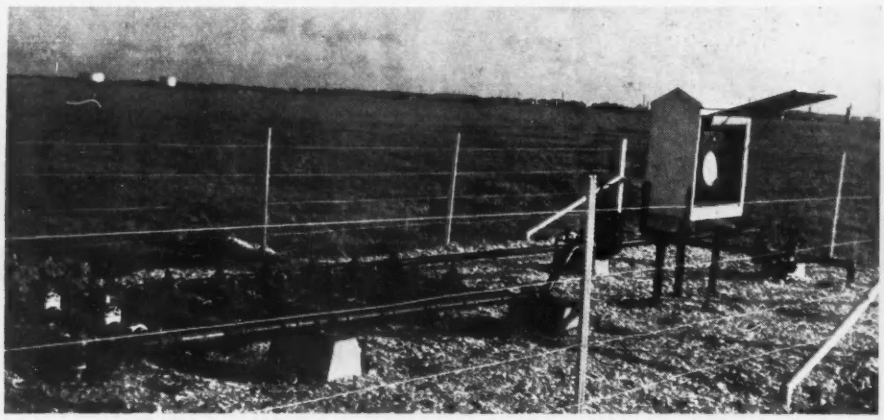
frame served to mount the sheet steel housing which fitted over both meters. Piping from the orifice flange connections was equipped with valves and fittings to permit meter repairs in the normal manner. By placing the orifice plate flanges near each other, a saving was made in the meter piping.

HOW TO—Test Gas-Lift Injection



The necessity of reporting volumes of gas injected into gas-lift wells poses a problem of gas measurement. To install a meter at each well would be costly. The simplified system illustrated performs the job satisfactorily at a considerable saving in meter and other equipment costs, as well as in installation expenses and maintenance and operating costs.

The lifting gas supply lines for eight gas-lift wells are connected into the metering manifold system by a two-inch line rising from the ground at far right. This gas flows continuously to the far side of the manifold, passes through each of the plug valves, and is diverted by a tee into the individual lines leading to the gas-lift wells.

If it is desired to meter the amount of gas which any one of the wells tied into this manifold is taking, the normal path of gas flow as described above is blocked by closing the plug valve on the far side of the tee. A plug valve connected to the manifold in the foreground is opened so that gas may flow through the meter run, through the orifice meter plate and then to the well. All other gas supply lines to the orifice meter are shut off except that of the well being tested. In this manner, any one of the eight wells can be easily tested by manipulating two valves.

An additional advantage of this metering manifold is that its design permits adding more wells to the system by connecting into the manifold at the left end. It is possible to test any of these wells from this central point rather than at each well. No interruption of the well is necessary with this metering system.

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Safe Handling of H_2S Bearing Crudes

SAFEGUARDING personnel in the handling of hydrogen sulfide bearing crudes is discussed from the pipe line angle, and recommendations are made as to proper masks and other safety precautions required under varying conditions. Frequent testing with reliable equipment is necessary, if dangerous conditions are to be avoided when concentrations are such as to nullify the warning usually given by the odor of the gas.

A line following contours such as this lies in a series of pockets, any one of which may serve to collect the heavy hydrogen sulfide gas if a leak is so located as to permit the gas to drift down grade into the low spots. Such spots should be avoided by the line-walker when gas is suspected.

ONE of the problems arising from extensive oil development operations in the West Texas and Rocky Mountain provinces is the handling of crudes containing high concentrations of hydrogen sulfide (H_2S) gases. Hydrogen sulfide is a colorless gas, heavier than air and has an odor frequently likened to rotten eggs. In high concentrations, however, this characteristic odor may not be detected and therein lies a hazard to the safe handling of such crudes. Like other gases, hydrogen sulfide is toxic to humans when absorbed in a high degree of concentration and this is especially true in unventilated places. However, with due care, these crudes can be handled without risk and records show conclusively that most of the accidents resulting from the handling of hydrogen sulfide crudes can be traced to neglect of safety rules.

Where Principal Hazards Exist: The principal hazard in handling these crudes is found in unventilated pockets where the gas collects and remains because there is no adequate means for its dissipation. It has a tendency to drift and lie in low spots such as ravines, creeks, tank dikes, inside the shell of floating tanks, bell-holes, excavations, inside tanks, conduits, manifold and junction pits. There may be other places but those named constitute the greatest hazards and should be avoided except when a proper type of gas mask is worn and other employes are nearby to give assistance in the event of accident.

Crude oil containing hydrogen sulfide is not harmful when the percentage of concentration in the air is not too great. This percentage can be readily determined by the use of an instrument known as a hydrogen sulfide gas detector, a hand instrument used to determine whether hydrogen sulfide gas is present in dangerous proportions. Wherever crudes bearing H_2S gas are being produced or handled, field personnel should be provided with a hand detector and it should be used regularly

for checking the atmosphere in places where employes perform routine duties or even where they may occasionally be called upon to go.

Gauging Lease Tanks: In gauging lease tanks the principal hazard from hydrogen sulfide gas exists when the gauge hatch is open. The field gauger, therefore, should wear a canister type gas mask when working the tank with the gauge hatch open before putting it on the line and before sealing it off the line. Similar precautions should be taken when gauging cone roof storage or working tanks at tank farms, pump stations, transfer, and delivery points.

Floating Roof Tanks

Gauging Floating Roof Tanks: Because of the construction of floating roof tanks, pockets of hydrogen sulfide gas may form in such tanks when the roof of the tank is floating low in the shell of the tank and when air is still or heavy with fog or moisture. Therefore, extraordinary precaution should be observed when going on to the roof of such tanks. Field men should keep in mind that it is not always possible to detect the odor of hydrogen sulfide gas and when engaged in duties connected with floating roof tanks should wear a canister type gas mask from the time they leave the platform at the top of the tank stairs until they return to the platform. As added precaution, a crew member equipped with gas mask should remain in attendance at the top of the tank stairs to act as observer and life guard. Whenever possible, gauging should be done from the platform at the top of the tank.

Insofar as possible, gaugers or others assisting in tank gauging operations should stand on the windward side of the gauging hatch.

Repairing Oil Line Leaks: Principal concern in the repairing of leaks in oil lines presents itself when such leaks occur in ravines, creeks, swamps, and low areas where ventilation is poor. As already pointed out, hydrogen sulfide gas, being heavier than air, will settle in low spots and remain there unless blown away. Such "dead" pockets should be regarded with care. The quantity of oil and the manner in which it escapes from the line determine principally the amount of H_2S present in the vicinity of the leak.

Summarizing, exceptional care should be observed: (a) when the leaks or breaks result in large quantities of oil escaping from the line under pressure, (b) when such leaks occur in ravines, creeks and valleys, (c) in bell-holes or excavations, and (d) when the atmosphere is still and laden with fog and moisture.

When such an oil leak is discovered by the linewalker, he should make no attempt to repair it but should report the leak and ask for immediate assistance, returning to the vicinity of the leak to serve as a watchman but making certain that he remains to windward and at a safe distance from the leak.

A pipeliner demonstrates a demand type oxygen mask and portable oxygen supply used in some areas by company personnel working with sour crude. Another type of protection used around sour crude consists of a large oxygen bottle installed near stairways to storage tanks which are in sour crude service. The employe attaches a demand mask of the type shown here to the large bottle, using a hose long enough to reach the tank roof.

In the case of a pit or collar leak, a temporary repair can be made, but in performing this work a blower type gas mask should be used by the workmen. Attendants in the vicinity may use the canister type mask. As soon as the leakage has been stopped the area should be cleared by moving the oil to an earthen dike at a safe distance from the leak. Insofar as possible such oil should be handled by a low-down suction type hand pump which should be connected up with the necessary suction and discharge piping. This method is preferable to handling with buckets. After these precautions have been carried out permanent repair work can be undertaken then or later.

In repairing a pit leak or leaking coupling requiring only a small bell-hole, only two men should work in the bell-hole. These should be provided with safety belts and life lines. The men operating the blower fan should take a position to windward of the bell-hole to assure that pure air is being pumped to the men wearing the blower type gas masks.

A crew, larger than ordinarily required, should be employed in repair work on lines which carry hydrogen sulfide crudes since relief must be provided for men wearing gas masks.

Leaks and Breaks at Pump Stations: In the case of serious failures such as blown-out gaskets and breaks in the discharge piping system, from the pumps to the outgoing head gates all units at the station should be shut down immediately and the previous station should be notified and instructed to shut down without delay. Under such conditions the hazard is too great in continuing the operation of machinery at a station where the failure has occurred and in continuing to receive the stream from the previous station. After the machinery at both stations has been shut down the incoming head gates, the outgoing head gates, and the tank gates should be closed to remove all pressure from the station and manifold piping system. Tank valves on the discharge system of the suction pump should be left open to permit the suction pump to discharge into a tank.

Vapor Accumulations

If failure occurs in the pump room or the manifold building causing an accumulation of hydrogen sulfide vapors in such structures, extraordinary precautions should be observed and field personnel should not be permitted inside the buildings until adequate protective measures have been taken. Then, a person wearing a blower type gas mask and equipped with a life line may enter the building to open windows and provide ventilation. No flashlights or lanterns should be used where gases are present. After the failure has been located and the proper valves have been opened or closed, a unit connected to a generator may be started (after the by-pass on the pump has been opened) to provide lights and power for running the suction pump. If necessary, the suction pump should be used to pick up oil that has escaped into the pump room or manifold pit. If the failure occurs in connection with a unit driving a generator and another

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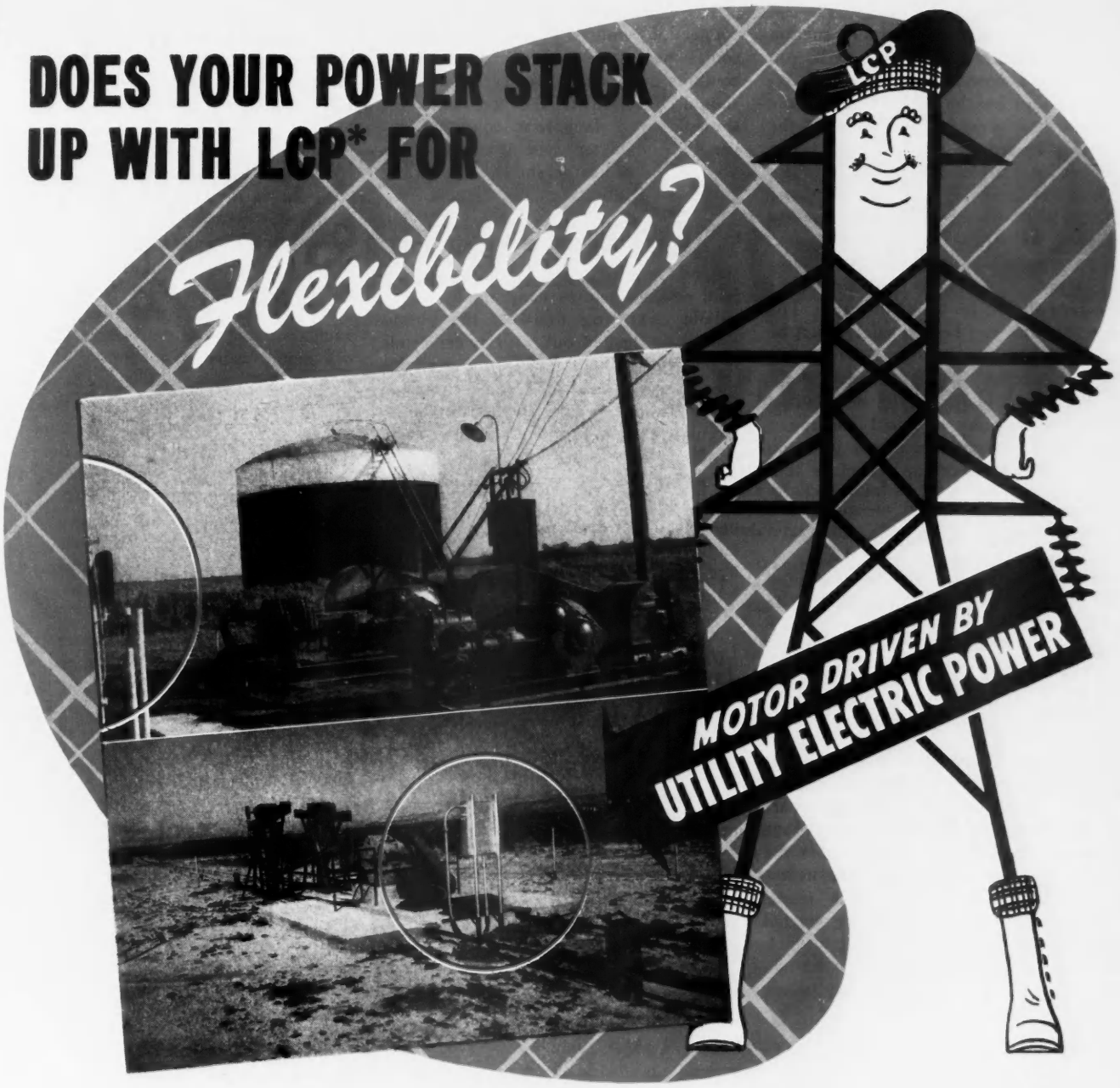

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such unit is not available, and it is necessary to close the discharge and suction valves on such unit, the unit may be run to drive the generator after (a) the oil in the pump has been drained, (b) the by-pass has been opened, and (c) the plungers have been oiled to prevent the plungers and packing becoming hot. The lubricating tank on the pump should be checked to make sure that there is an adequate supply of lubricating oil to keep the pump properly lubricated. While the pump is operated in this manner the plungers should be kept lubricated. The time this unit can be run safely must be governed by the capacity of the cooling system. Auxiliary engine driven generators should, if possible, be installed at main line stations to avoid running a large unit for light and power when an emergency occurs or the station is shut down.

Time for Repairs

After the pump room or manifold building is sufficiently ventilated, repairs may be made. A gas detector should be used to determine whether the atmosphere is safe with respect to hydrogen sulfide gases and such repairs should be made during daylight hours wherever possible and when sufficient help is available to do the job properly. Operations may be resumed before complete repairs are effected, provided that part of the system in which the failure has occurred has been segregated from the rest of the station and after the necessary valve changes have been made. The previous station should be started first, receiving the stream into a tank to make sure conditions are normal. Then the station at which the failure occurred may go on the line.

Ventilation of Buildings: Manifold and junction buildings should be kept well ventilated at all times by open doors and windows and, wherever possible, by the use of ventilators, and field men and safety men should collaborate in determining the effectiveness of such ventilation by frequent application of the gas detector. Improper ventilation is more noticeable during cold weather when rooms are being heated. There may be sufficient air leakage around windows and doors to supply enough ventilation through the ventilators in the pump room, but nothing should be taken for granted and frequent checks, especially during cold weather when buildings are kept closed for the sake of warmth, should be made to maintain healthful air conditions.

Conduits and Pits: No one should be allowed to enter conduits or pits where hydrogen sulfide carrying crudes are being handled without first being equipped with a gas mask, and unless attended by a crew member, as such places represent the greatest hazards in connection with H_2S gases. If it becomes necessary to enter unventilated conduits or pits a blower type gas mask should be used if the gas indicator shows that a dangerous condition exists. The canister type mask may be used if the indicator shows only a low gas concentration.

Repairing Pumps: Before changing plungers, grinding valves, or making other repairs requiring the opening of the fluid ends of pumps handling hydrogen sulfide carrying crudes, the pumps should be flushed out with sweet crude if possible. Where this is not available the pumps should be drained, opened up and sufficient time allowed for air to circulate through them. Pump room windows and doors should be opened beforehand to provide the maximum ventilation. A gas detector should be used to determine if excessive hydrogen sulfide gas is present. Excessive leakage from the stuffing boxes of pumps handling such crudes should be avoided.

Safety Equipment and How to Use it: (a) Gas Masks—Fresh Air Blower Type: Fresh air or blower type masks provide fresh air through a 75-foot rubber hose connected with a hand operated fan that is built into an ordinary trunk which serves also as a container for the face pieces and rubber hose when they are not in use.

These masks are to be used in repairing line breaks, where men are working in pits, bell-holes, and buildings where H_2S gas is present in the air in heavy concentrations. In using this type of mask care must be taken to see that the hose inlet is not in polluted air. This is very important. Pure fresh air must be supplied to the mask to render it effective. Men using this type mask should also have life belts to which a life line is attached so that a man can be pulled to safety in case of emergency such as failure of the gas mask to function properly. All hose connections should be carefully inspected and checked for leaks.

(b) Gas Masks—Canister Type: This type of gas mask consists of a face piece, a 28-inch rubber hose, and a harness for carrying a canister which is carried on the back of the person wearing the mask. There are two kinds of face pieces; the all-vision face piece and the half mask. The first covers the entire face and the eyes, while the other covers only the nose and mouth. The half mask should never be used in connection with the blower type equipment.

Canister type gas masks should be used in gauging and sampling tanks. The face piece of the mask should be properly adjusted in order to afford full protection. A hole in the bottom of the canister is provided for air. The mask can be tested for leaks by placing the hand over this air hole or by kinking the air supply hose and breathing deeply. If the face piece collapses, there are no leaks. If it does not collapse, then there is a leak which should be found and corrected before the mask may be worn with safety in a gaseous area. A small paper seal that covers the hole in the bottom of the canister must be removed before the canister is put into use. Those using gas masks should observe carefully and record the time that a mask is used each time and if in doubt as to the record a new canister should be attached. A good system for checking canisters is to keep a time card with each canister taken from the supply room. Canisters are generally effective for 15 hours of use, but in case the person wearing this type mask smells gas, he should discard the mask regardless of the number of hours that it has been in service. It is important to observe that in no case should a canister be used for more than 15 hours.

When a gas mask is to be worn into an area known to be contaminated, there are two precautions which, though elementary, frequently are neglected. The first is that of donning the mask before reaching the danger zone. It is easy to carry the mask, and to put it on at the first whiff of H_2S, but in that case the mask is more or less permeated with the odor, and the wearer has lost that keenness of smell which he is apt to rely on to give him warning of a leak. Also, it is frequently noted that a mask wearer, working hard at his task in a gas-polluted atmosphere, will slip the mask for a full breath of air. This practice, of course, dulls the sense of smell, and may result in the taking in of enough gas in the one or two deep breaths indulged in to affect the wearer of the mask adversely. If a mask is put on, it should be worn uninterruptedly until the danger zone is quitted and pure air is known to be available.

Precautions

Operators should impress field men that hydrogen sulfide carrying crudes can be handled with safety. The nature of such crudes—and they now constitute an appreciable amount in the production of the nation—and the precautions that must be observed should not create fear nor alarm. Precautions must be observed in handling these crude oils, just as care must be observed in everyday life to avoid injury and accidents. It is important, however, that operators in areas where such crudes are produced recognize the hazard and impress on field personnel the necessity of constant vigilance and the observance of all precautionary rules.

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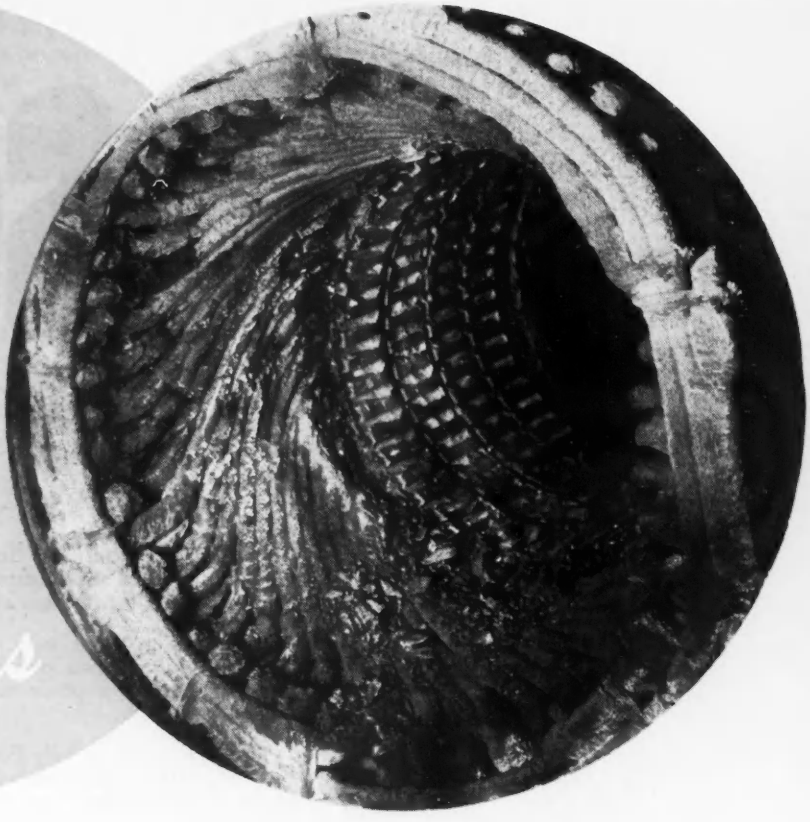


An example of bad motor maintenance.

By W. E. DOUDS
Elliott Company, Ridgway Division

THE AUTHOR discusses motor applications and points out important details to be watched while operating, checking and servicing these units. Cleanliness and correct lubrication are stressed as being of especial value to long and trouble free motor life, and are important factors in any maintenance schedule.

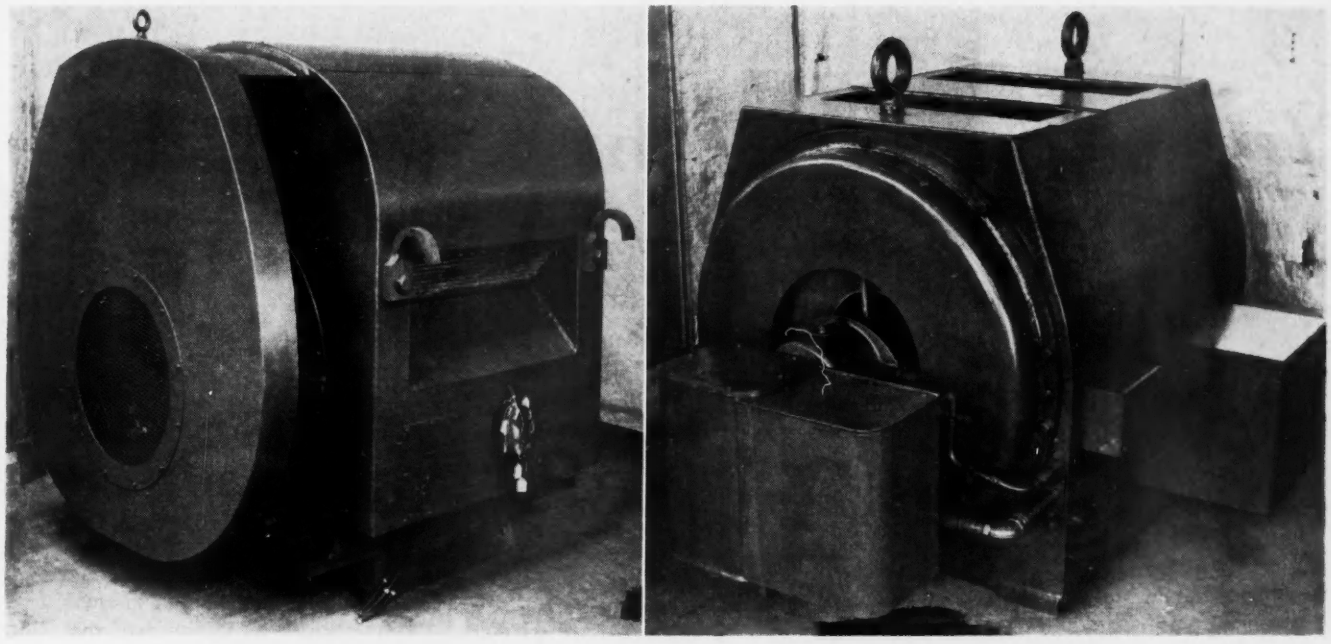
THE development of pipe lines to carry liquid and gaseous fuels has been one of the high points in the progress of the oil and gas industry. Buried from sight, the lines do their job so silently that few realize a skilled organization is ever on the alert to prevent trouble and repair faults, so the fuel may flow without interruption. Those responsible for the continuous operation of the pipe lines find the best insurance against trouble is preventive maintenance. The drives for the pumps and auxiliaries are the heart of the system. Many of these drives are electric motors, to which this discussion will be confined.

The alternating current motors generally used will operate with little attention, but best results and most economical operation are obtained through adequate maintenance. This is becoming increasingly more important with the trend toward higher pressures and a consequent need for larger motors. The problem of maintenance on pipe line motors is somewhat different from that of the average industrial application. No fixed maintenance schedule can be established for a particular pipe line, for conditions will vary from station to station. At one end of the line, a dry and dusty condition may be encountered and at the other end perhaps an extremely moist condition, with many variables in between. A careful study should be made to determine the maintenance schedule best suited to the individual station. The various points discussed here should be helpful in establishing the schedule.

Cleanliness is a sign of good motor maintenance. This matter is too often neglected in spite of the emphasis placed on that point by those interested in maintenance problems. An extreme condition is illustrated.

A motor, as designed, depends on conduction and radiation to dispose of heat losses without an undue rise in temperature. Little change occurs in the diffusion of heat by conduction, but accumulations of dirt and oil adversely affect radiation. In the case of open or force-ventilated motors the ends of the stator windings, from which much heat is radiated, are particularly subject to accumulations of foreign matter. If little oil vapor is present, blowing out the windings periodically with low-pressure air will keep them reasonably clean. When air is not available the dirt can be removed with dry rags. In cases where oil accumulates on the windings, it will be necessary to clean them with a suitable solvent. This can be applied and the windings dried off with clean rags. In extreme cases it may be necessary to shield the rotor suitably and spray on the solvent to flush out the dirt from inaccessible spots. The solvent should be immediately blown out with low-pressure air. Care should be used in handling solvents as some are inflammable and others have toxic effects.

Large totally-enclosed, fan-cooled motors depend on some type of air-to-air heat exchangers to dispose of heat losses. The tubes in such equipment should be inspected at intervals and



RIGHT: Modern open-type motor. LEFT: Totally-enclosed fan-cooled motor particularly suited for pipe line service.

cleaned if there is any evidence of a deposit.

The recording of insulation resistance measurements at regular intervals is strongly recommended. This practice is well established in generating plants and is of much value as it will indicate the condition of the winding and, in many cases, avoid a shutdown at a critical time by permitting correction before a failure. High potential testing of old windings is not recommended.

The varnish film on the stator windings may become thin due to sand or other abrasives in the ventilating air, the effect of certain types of oil, or frequent cleaning. The varnish film protects the windings from absorbing moisture which is one of the most insidious enemies of electrical machinery. Windings on which this film has been damaged should be thoroughly cleaned of all traces of dirt and oil and a coat of air-drying varnish applied where the size of the stator does not permit dipping in a thermo-setting varnish and baking the complete stator.

The heat in the slot section of the stator coil is removed by conduction through the iron core. This heat, together with the heat resulting from the core loss, is removed in part by the ventilating air passing through air ducts provided in the core of many motors. These should be inspected to make sure that the passage of the ventilating air is not obstructed, especially after re-varnishing the stator winding. Where necessary to clean out the air duct spaces, care should be taken to avoid damaging the stator coils.

The motor manufacturer takes great care in choosing the proper type of insulation for windings, but even with the best maintenance practice, most insulation will deteriorate over the years, and will require replacement of the stator coils. When this is necessary, care should be taken to obtain coils which meet the original specifications, and these are generally available only from the motor manufacturer. The best coil is the least expensive, for it provides longer and more trouble-free service and assurance that the motors will stay in service when most needed.

The rotors of squirrel-cage motors require little attention. At the time a general overhaul is made, the winding should be inspected to determine if there are any broken bars, or bad joints between the bars and the end rings. It is generally not realized that high temperatures occur in a squirrel-cage rotor during the starting period and, where frequent starts are made with short shut-down periods, the rotor temperature may reach a very high value. This is particularly true of large pump motors.

Since a bearing failure can result in extensive damage to the stator winding and core, frequent attention to that point is important. No hard and fast rule can be laid down for the amount of bearing clearance. In general, much less clearance is permitted in two-pole motors than in the case of slower-speed motors. Where sleeve bearings are re-babbitted, the best grade of virgin babbitt metal should be used. Split bearings and housings permit easy inspection of the bearings and removal of the rotor. They may distort when rebabbitted so the outside and inside should be checked before and after

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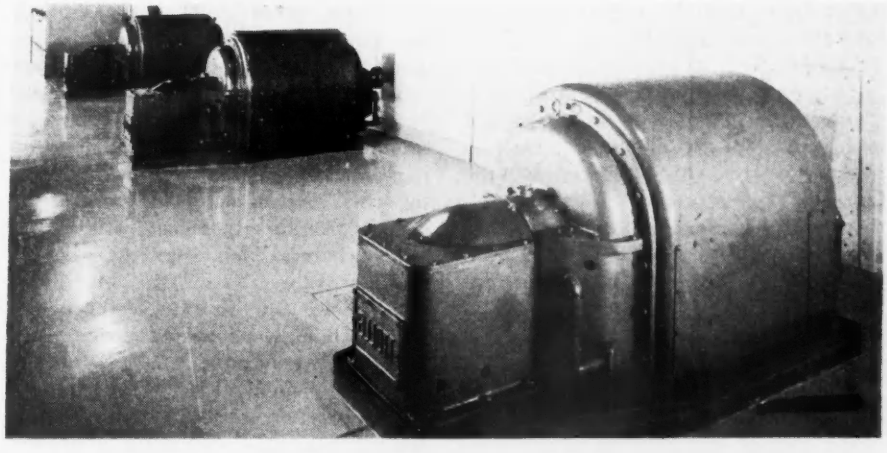

Recent installation showing three of twelve 1000-horsepower two-pole induction motors in pipe line service.

You'll LOVE That Crawler Tractor

By W. W. BLACK

Manager, Parts and Service Department, Industrial Power Division,
International Harvester Company

THIS is going to be a story of how a tractor operator can learn to regard his machine with the same respect and affection he would offer a dependable woman who can sew, keep house, and cook three good squares a day. This may not be love as the poet sees it, but it's the kind of love that keeps this old world spinning. . . . Its also the kind of love that will keep tractor tracks tracking!

The idea that a man cannot develop real affection for the machine he operates should be discarded immediately. The cards aren't stacked that way. Insult a machine that an operator has learned to admire, and chances are he'll react much as though the insult was highly personal.

But how does this pattern fit the fellow who isn't satisfied with his tractor—the fellow who each time he starts the machine wonders how long it will keep running, and who regards each load askance, a question in mind whether or not his machine will take it away? How are you going to create confidence where none exists?

You can't . . . you can't, that is, until you rationalize with him a bit—point out to him that its probably his fault because he and his tractor do not get along together. If he's the type of fellow who's willing to learn, who wants to make the best of every situation, he'll listen to your words.

The literal truth is that every tractor being manufactured today is a good tractor. Some may be stronger than others, some will handle easier than others, a few of the newer ones have some convenience never before found in crawler tractor design. But get this and get it straight—every last one of them is a good tractor. There's just one hitch to his situation—every tractor made has certain operational characteristics which makes it a bit different than any other tractor on the market. When an operator doesn't like to drive a tractor, or when he consistently has trouble with a tractor, chances are ninety-nine out of a hundred that he has failed to observe operational characteristics peculiar to that particular model and design.

THE AUTHOR points out, with appropriate illustrations, some of the operating points to be observed if a new and modern unit replaces an old crawler tractor. A "break-in" period, while advantageous for the tractor, is of even more importance for the operator if long life and satisfactory service are to be obtained from the replacement.

The fact that an operator has handled one type of crawler tractor for ten years is no indication that he can step into the seat of another and put it through its paces without trouble. In fact, habits developed during his long acquaintance with the first machine may be detrimental when he tackles the new one. Perhaps the first tractor required double clutching when shifting gears; the new tractor does not. Perhaps the old job required Herculean effort in steering, braking, de-clutching and shifting gears. The new machine may be equipped with hydraulic boosters and other controls which require only fingertip or toe-tip pressures. Thus when shifting from the old to the new machine, the operator is very liable to literally "jam" the controls around until he trains himself to control his muscular efforts.

Operator's Manual

One of the first steps to accomplish in learning to get along with a new tractor is to read thoroughly the Operator's Instruction Manual. Although this manual will not cure old habits, the information it contains will enable the operator to note which of these habits do not fit the new job and make his adjustments accordingly.

Note carefully all instructions relative to starting and stopping the engine. Follow these instructions implicitly. Make control and throttle adjustments as described, not as you have been used to doing on the old tractor. Note all precautions. If the manual tells you not to operate the starter for more than 30 seconds at a time to keep it from overheating, don't let it grind away for a full minute. If, on a gasoline conversion engine, it specifies a full minute's operation before switching to the diesel cycle, follow the rule. Thirty seconds saved at a time like this may result in hours of down-time later.

The engineers who write these manuals know what they are talking about. Take their word for granted, and follow the rules set forth. This will be your first all-important step in learning to love that new rig with the same affection you felt for the old.

You'll find things a bit strange the first time you handle one of the new tractors. A lot of improvements have been made during the past few years. But don't grab those controls for the first time, then try immediately to put the new job through all her paces. Ease into the task. Try starting and stopping a few times, using a different gear each time. Note how it shifts—does it require a healthy shove, or will the gears literally slip into place after a gentle shove in the right direction? Do you have to come to a full stop before shifting, or is it a synchromesh transmission job which permits shifting while on the go?

De-clutch a few times. See if you can detect clutch "feel" much as in the old mechanical clutch jobs. Move the throttle back and forth and note engine response. Fix firmly in your mind the position of every control. If the new tractor is equipped with hydraulic steering, note how easily it works. If you use the same amount of force on a steering system like this that you used on the old mechanical clutch steering systems, you'll probably run into trouble, and if not trouble, your handling of the tractor will be about as smooth as that accorded a Mark IV tank under artillery fire.

Keep in mind the speed associated with different gear positions as listed in the manual. This will give you an idea of the gear to use on different jobs. Some of the newer tractors have as many

as eight forward and reverse speeds. This variety is helpful when properly employed, but could result in confusion if used haphazardly. Try a few turns in both directions, try the same in reverse. Try a short spurt at top speed just to satisfy your curiosity. An hour spent in this kind of experimentation will give you a better insight into tractor handling than several days on the job where you have to proceed cautiously.

But more than starting and operating the tractor is involved if you hope to get the most out of it—if you hope to make it perform so well that you're willing to lay a bet on its ability, or stand up and argue for its honor. A tractor must be kept in tiptop shape at all times to give you its best. This calls for a lot of common sense from the operator, and a knowledge of preventive maintenance applicable to each specific tractor type. Just as operational characteristics vary between models and types, so do various maintenance measures necessary for smooth operation.

Tractor lubrication is vitally important for long life, smooth operation, and ease in handling. Here again the Operator's Manual will stand you in good stead. Various parts must be lubricated daily, others weekly, others dependent upon the hours of use and local dust and dirt conditions. Some of the new tractors have sealed bearings that will operate for hundreds of hours without additional lubrication as against a few hours on older types. But make sure that this condition exists. Don't gamble. The stakes are too big.

Watch for signs of overheating. Diesel engines are supposed to run hotter than gasoline engines, but overheating is detrimental to both. It is a reliable symptom that something is wrong somewhere. Generally, overheating can be traced to some defect in the cooling system. It might be a slipping fan belt, clogged radiator grill, a bent shroud, sedimentation, or a leak allowing the coolant to drain away. Sometimes a

defective thermostat will fail to open. Any of these conditions needs immediate attention and correction.

There are other symptoms which may occur and indicate that a maintenance problem exists. It is up to the operator to note these symptoms when they occur and call them to the attention of a trained mechanic. Without advice from the operator, the mechanic is at a loss to know when anything is wrong.

Other Symptoms

A few of the more important symptoms to watch for include an overly smoky exhaust, unusual noises in the engine or transmission, sharply increased fuel or oil consumption, unusual control action such as a slipping clutch, too much play in the steering controls, poor throttle response, etc. These are not normal conditions and indicate that something is wrong.

Above all, watch the condition of the air cleaner, its gaskets, the air cleaner oil cup, and all air hoses or lines leading into the engine. Remember that a diesel engine uses a tremendous amount of air, and that this is drawn directly into the cylinders. Dust carried with it makes a very effective abrasive when mixed with the oil. One instance is on record where a new engine required complete overhaul after approximately 60 hours of operation because of a small leak in the air hose between the cleaner and engine connections.

These may seem like simple instructions when applied to the tractor you have been operating for months or years. But when you change jobs, when you transfer to a new tractor, there may be things to watch for not found on the old. Conversely, the new tractor may not require watching at so many points. It all adds up to knowing what to watch for and where. This is the type of knowledge that gives you confidence, and which will result in tractor operation worthy of your respect.

There is a more touchy problem to discuss at this point, a problem which may or may not affect you as a tractor operator. Anyway, only you know the answer, and only you will know where the chips fall, so you can take the advice for what it is worth. This problem deals with rough and foolish tractor handling—more specifically, with "show off" handling, or with using the tractor for purposes for which it was not intended.

The newer tractors with their hydraulic boosters and hydraulic controls are surprisingly easy to handle—so easy, in fact, that the operator need expend but little effort in "making the wheels go round." This is apt to lead the careless operator into careless habits.

Tractors aren't horses, and you can't handle them like fractious broncos. Don't jerk them around. Nor are tractors manufactured for trick performance duties. If you like tricky driving, join a circus or become a Hollywood stunt man. Trying to "show off" a tractor is no more a sign of affection than hiring your wife out to a sideshow because she can dance a good hula!

Service managers who are familiar with tractor operation from coast to coast, admit that in all industries where crawler tractors are used, a few operators are prone to use them for purposes for which they were not intended. In the logging industry, for instance, some operators will drive a tractor parallel to a log, then throw it into a quick pivot turn, using the heel of the track to kick the log into a new position or to start it rolling. More than one track frame has been sprung out of position by this unusual treatment. The same principle applies to other industries, and in all cases, only harm can be expected to result from such usage.

It is entirely within any operator's province to erase barriers which stand in the way of real affection for the tractor he operates. The tractor will deliver, but you've got to know how to make it do so. It's not the big things that count so much—they are obvious and easily corrected. It's understanding the many small peculiarities characteristic of each different tractor that count most—knowing its whims, sensing its needs, and nursing its work habits. Once you start thinking along this line, you'll find your interest in the new job increasing, your feeling toward it becoming something more than routine interest. You'll begin to feel proud that you alone know how to get the most out of it, and that it won't deliver to any other man on earth like it will deliver to you. That's when affection starts. That's when love begins.

Care and Maintenance Of Electric Motors

■ CONTINUED FROM PAGE 187

machining to be sure the bore and the fit, where they seat in the bearing bracket or pedestal, are true and concentric. They may otherwise pinch the shaft and cause heating.

Where oil rings are used, care should be taken in handling as a distorted ring will revolve erratically and reduce the amount of oil to the bearing.

The recording of air gap measurements is one of the better ways to check bearing wear. These measurements are also valuable in checking cases of suspected damage to a shaft through distortion by comparing them with the last figures obtained.

Although many of the small motors used as auxiliaries in pipe line service have anti-friction bearings that are lubricated for life, the larger motors with anti-friction bearings will require frequent lubrication. Avoid the use of too much grease as many bearings have been ruined from this cause. In anti-friction bearings, cleanliness is important. Use clean solvent and relubricate the bearing immediately after cleaning to prevent corrosion. Any etching of the bearing races, rollers, or balls will shorten the life of the bearing.

Whether bearings are sleeve or anti-friction type, use the lubricant specified by the motor manufacturer, which can be obtained from any lubricant manufacturer. Where oil is used as a lubricant it should be checked frequently and changed if there is any evidence that it contains impurities. Oil chambers should be cleaned thoroughly at the time of general overhaul to remove any dirt deposited.

Many of the larger motors are pressure-lubricated and equipped with oil coolers, strainers, etc. These parts should be cleaned or replaced frequently to keep them at their top efficiency.

Flexible couplings commonly used today permit considerable misalignment between the driver and the driven unit, but alignment should be as close as possible to get maximum service.

Excessive Vibration

Excessive vibration is a sign of trouble. It may be caused by excessive bearing wear, worn couplings, distorted shafts, and broken rotor bars, or it may be transmitted from the driven unit.

Any overheating when operating under normal load is an indication of trouble. Thermometers should be used to determine the actual temperature as determination by touch is unreliable. The temperature of the motor must be considered relative to the room temperature as a high ambient is immediately reflected in higher total motor temperatures.

While the maintenance of most motors will follow the general rules, special motors or motors in unusual applications may require special attention. Instruction books provided by the manufacturer should be consulted in setting up a thorough and well planned inspection and maintenance schedule for all motors.

An adequate stock of the commonly required renewal parts is one of the best types of insurance. A few dollars invested in such parts may save thousands by shortening the time a motor is out of service for the replacement of some relatively minor item.

The electric motor, if kept clean, provided with suitable lubricant, regularly inspected and maintained, will render long years of trouble-free service at a minimum cost.

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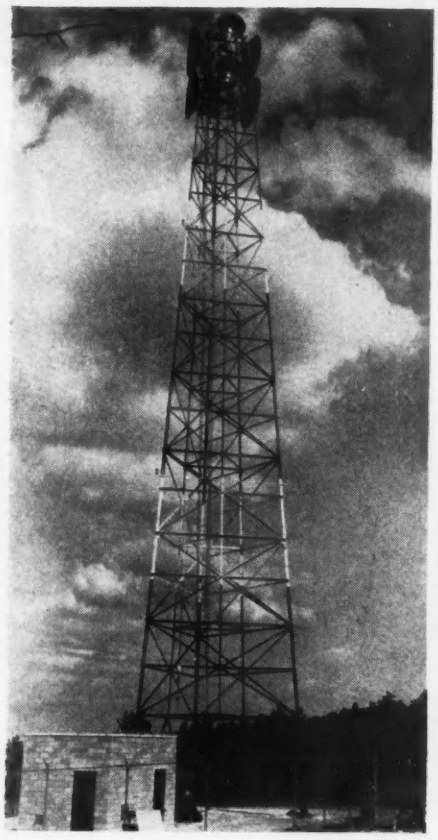
Keystone's *Microwave System*

By J. D. MUNTON
Manager of Communications,
Keystone Pipe Line Company

DESIGN AND ADVANTAGES of a microwave system for maintaining uninterrupted communications over terrain where sleet and other winter storm effects disrupt land lines are described by the author, who supervised the basic system which later will be expanded to cover the company's entire network of pipe lines.



Repeater station and tower at Valley Forge.

CLEAR and uninterrupted communications between pump stations and other nerve centers along a pipe line system must be constantly maintained for efficient and economical operation. A communications breakdown at any point may have disastrous results which are reflected not alone along the system itself, but at refineries, terminals, and on down the line to the consumer, who may be without fuel. Pipe line companies will long remember the critical conditions which developed during the severe winter of 1948 when communications along many systems suffered from severe cold and climatic conditions, causing frequent breakdowns and interrupted service.

In order to overcome such difficulties and insure continuous communication between vital points along its system, Keystone Pipe Line Company has installed the first unit of a microwave radio relay link designed to replace the old land-line dispatch system between Philadelphia and Montello, Penn., an airline distance of about 60 miles. Company engineers believe this is the most flexible system immediately available to meet present and future demands for voice and other intelligence channels.

Microwave is essentially a "high load factor" system and its cost can ordinarily be justified only when a large number of channels are to be handled or when the territory prohibits use of land lines for economical or other reasons. Five channels are immediately required between Philadelphia and Montello; therefore, when it becomes necessary to replace the present dispatch systems north and west of Montello, ample additional channels are available. Microwave, due to its much superior transmission quality over land line, moves the dispatchers (transmission wise) from Philadelphia to Montello, thus improving the over-all transmission of the entire dispatch system; and since getting out of a large city such as Philadelphia invariably imposes large losses due to entrance cable, the technique represents an important economy. Given a properly engineered and properly maintained microwave system, outages will be fewer and of shorter duration than those encountered in a land-line dispatch system and loss of facilities due to sleet storms such as are experienced in Pennsylvania is expected to be held to a minimum.

Keystone communications engineers have outlined an extensive microwave system but for the present only the first phase has been placed in operation. This primary installation includes three terminal stations in eastern Pennsylvania. One is on the building of the company's main offices in Pennsylvania; one at a pumping station near West Chester, and one at a pumping station a short distance from Reading. Linking the three terminals are two repeater stations, one near Valley Forge and another on a high eminence known as Deerpath Hill, overlooking Reading. The accompanying map shows the location of the terminal and repeater stations.

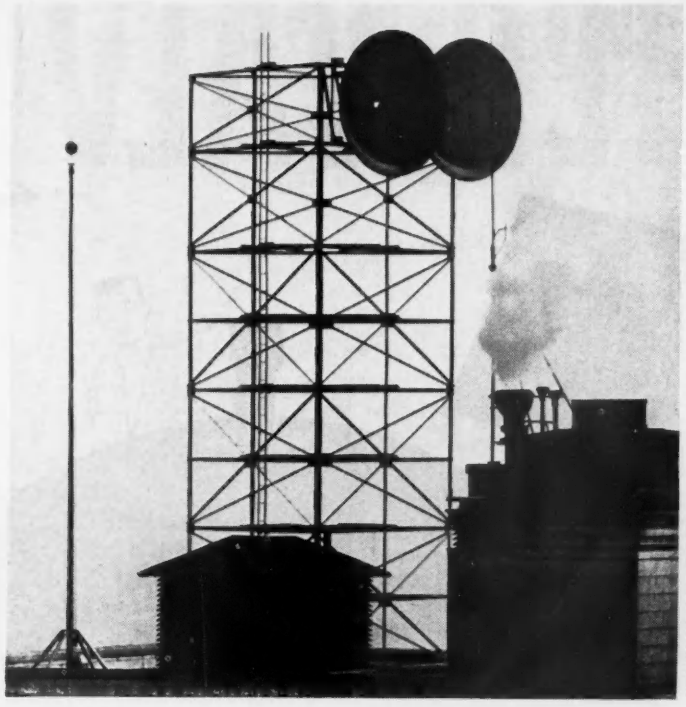
Backbone Circuit

Also on the accompanying map the eastern section of the Keystone Pipe Line Company system is shown as a dotted line, while the solid line running from Philadelphia through a point near Valley Forge to Deerpath Hill represents the "backbone" circuit of the microwave system. To provide a more complete picture of the microwave system one should visualize this "backbone" circuit as continuing on to areas further west and northwest as future plans unfold. From the "backbone" circuit there are two offshoots to Keystone's pumping stations at Boot and Montello, and as the circuit is extended other offshoots will be established to points that must be served with communication.

Station antennas differ from the usual type and consist of short spikes about six inches long backed by ten-foot, searchlight-type reflectors. Each of these antenna-reflector assemblies serves only a single microwave path and must be mounted high enough to provide a "line of sight" path to the station towards which it is directed. Antennas are mounted on high steel towers capable of clearing local objects in the "line of sight." The Valley Forge tower is 150 feet high and provides a clear microwave path to Philadelphia.

As will be seen from the map, three paths radiate from the tower at Valley Forge and one antenna-reflector assembly each for transmission and reception has been mounted at the top of the tower to serve each path, or six in all. In like manner antenna-reflector assemblies have been installed on the Deerpath Hill tower for present service. The terminal stations at Boot and Montello pumping stations have each been equipped with two antenna-reflector assemblies, although the towers at these locations are only 60 feet high. Two antenna-reflector assemblies have been mounted on the Philadelphia office building at a height of 40 feet above the building.

Each transmitting antenna at each location is excited by a microwave transmitter made up primarily of a "light-



Two antenna reflectors mounted atop The Atlantic Refining Company's building at Philadelphia, headquarters for Keystone Pipe Line Company.

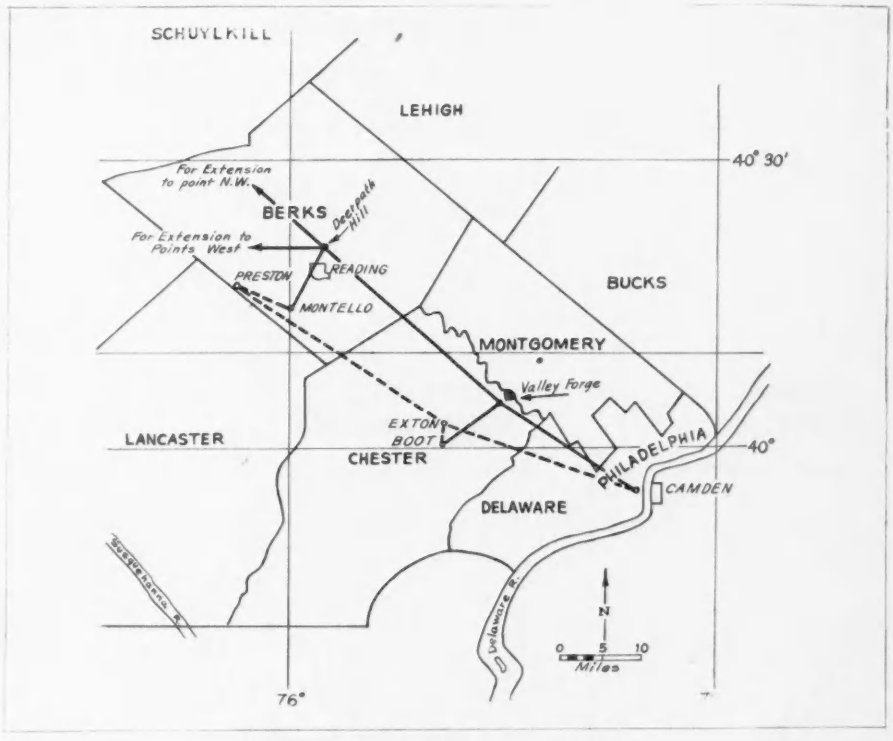
Engineers determine line of sight propagation characteristics prior to installation of microwave radio system. Transportable tower for microwave antenna is in background.

house" tube and an oscillator cavity adjustable to the proper frequency. This oscillator is modulated by a time division system called "Pulse Time Multiplex" which makes possible the transmission of a maximum of 23 separate communications on a single frequency channel. The equipment and installations at Valley Forge are housed in specially built equipment buildings which, in addition to the radio equipment, also house auxiliary power equipment for use in case of power line failure. At Boot and Montello terminal stations equipment is housed in small buildings but no auxiliary power has been provided.

Circuit-wise, the microwave radio equipment will provide a communications system indistinguishable from a wire line telephone system and there will be no occasion for any user of the system to know that any radio equipment is involved. For the present a five-channel system only is required but this may be expanded to a total of 23 channels merely by adding a series of small plug-in panels to existing racks.

Of the five channels, one originates at a PBX installation in Philadelphia and may be completed over the radio link to Montello where it terminates in a local battery phone with magneto ringing apparatus. Channel 2 also originates in a PBX installation at Philadelphia, is completed over the microwave links to Montello pumping station, and is there transferred to wire-line carrier circuits serving Keystone's installation farther west. Channel 3 originates in Keystone Pipe Line's dispatch office at Philadelphia, is completed over the microwave link to Montello pumping station, and is there transferred to a wire line serving installations to the north. Channel 4 is a wire-line circuit originating at Point Breeze pumping station in Philadelphia and brought into the office where it is transferred to the microwave link system for extension to Montello and there re-transferred to a wire line serving installations farther west. Channel 5 originates at Philadelphia and serves the pumping station at Boot.

The microwave system will be capable of handling and extending the facilities of a complex existing telephone system in which wire lines, carrier circuits and operating equipment are already employed and Keystone engineers believe it will greatly improve efficiency and operation of that section of the system which it now serves.

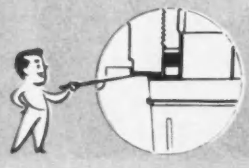


Map showing Keystone's microwave radio link.

IN NO OTHER VALVE

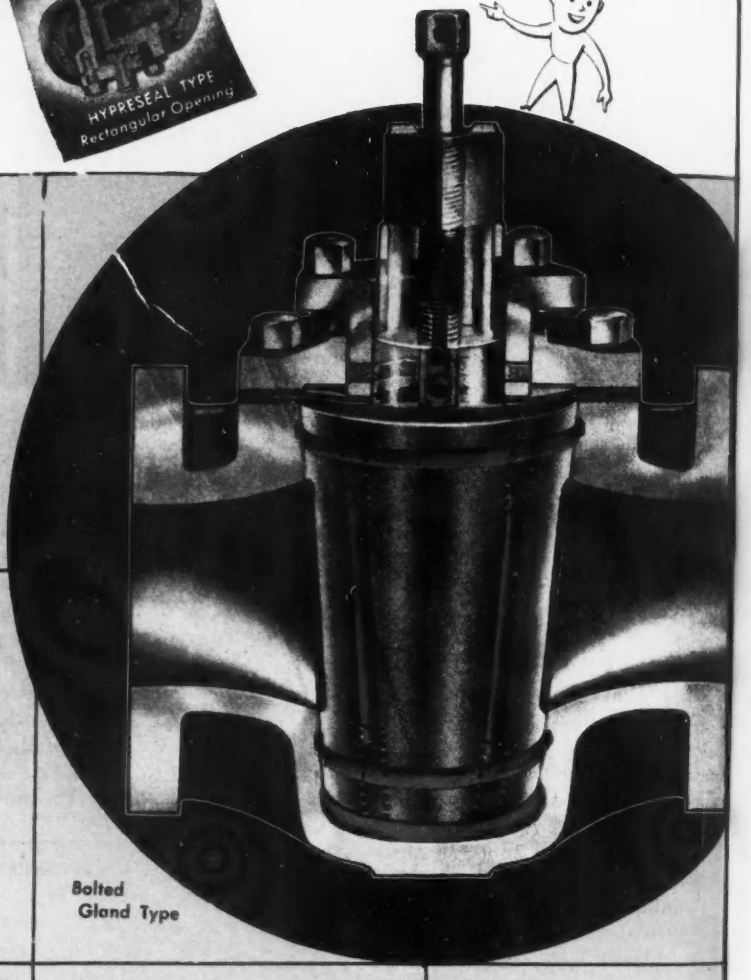
POSITIVE ROTARY ACTION

Tapered plug, fully lubricated

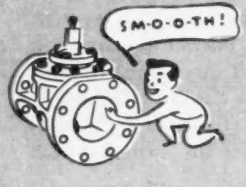


RESILIENT SHOULDER STEM SEAL

Allows jacking of plug

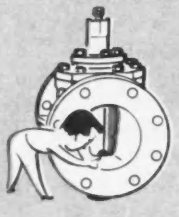


Bolted Gland Type



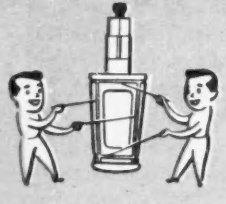
SMOOTH PASSAGEWAY

Streamlined, devoid of crevices



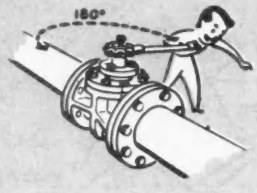
CAN BE "CRACKED" WITHOUT LUBRICANT LOSS

Lubricant will not blow out



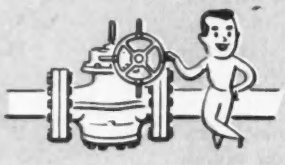
"SEALDPORT" SURROUNDS PORTS

Seals each port against leakage



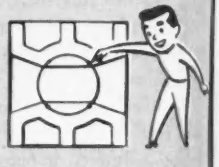
RENEWABLE SEAT WITHOUT REPLACEMENT

Plug can be re-positioned 180°



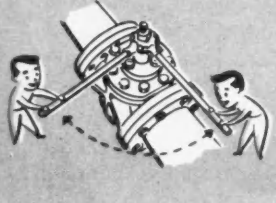
LEAST EFFORT TO OPERATE

Lubricant prevents galling



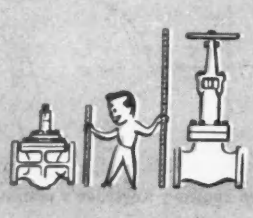
SEAT OF VALVE NEVER EXPOSED

Line fluid does not contact



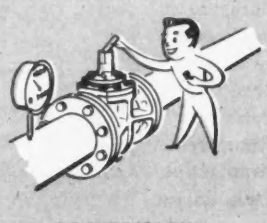
QUARTER-TURN

Simple sliding action



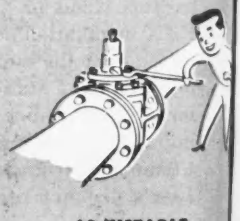
MOST COMPACT SIZES

Can be set in restricted space



RE-LUBRICATED UNDER PRESSURE

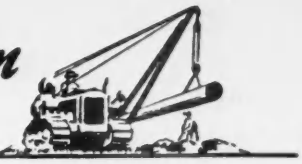
Ball check valve holds pressure



ADJUSTABLE UNDER ANY PRESSURE

No need to shut down

PIPE LINE *Construction*



By CECIL W. SMITH, Statistical Editor

NORTHWESTERN U. S. was assured of additional supplies of refined products when Salt Lake Pipe Line Company awarded contracts recently to extend the new Salt Lake City-to-Boise products line 240 miles to the state of Washington.

As soon as weather permits, Morrison-Knudsen Company, Inc., Macco Corporation, and Bechtel Corporation of San Francisco will join forces to lay 120 miles of eight-inch from the present line's terminus at Boise, Idaho, to Baker, Ore. At the same time, the northern section, Baker to Pasco, Wash., will be started by Pacific Pipe Line & Engineers, Ltd., of San Francisco. This section will also be 120 miles in length, but will be built of six-inch pipe.

Salt Lake Pipe Line Company, Standard Oil Company of California subsidiary, will serve its parent company's bulk distributing plants at Ontario, Pendleton and Baker with its new line. Terminal distribution facilities are yet to be built at Pasco.

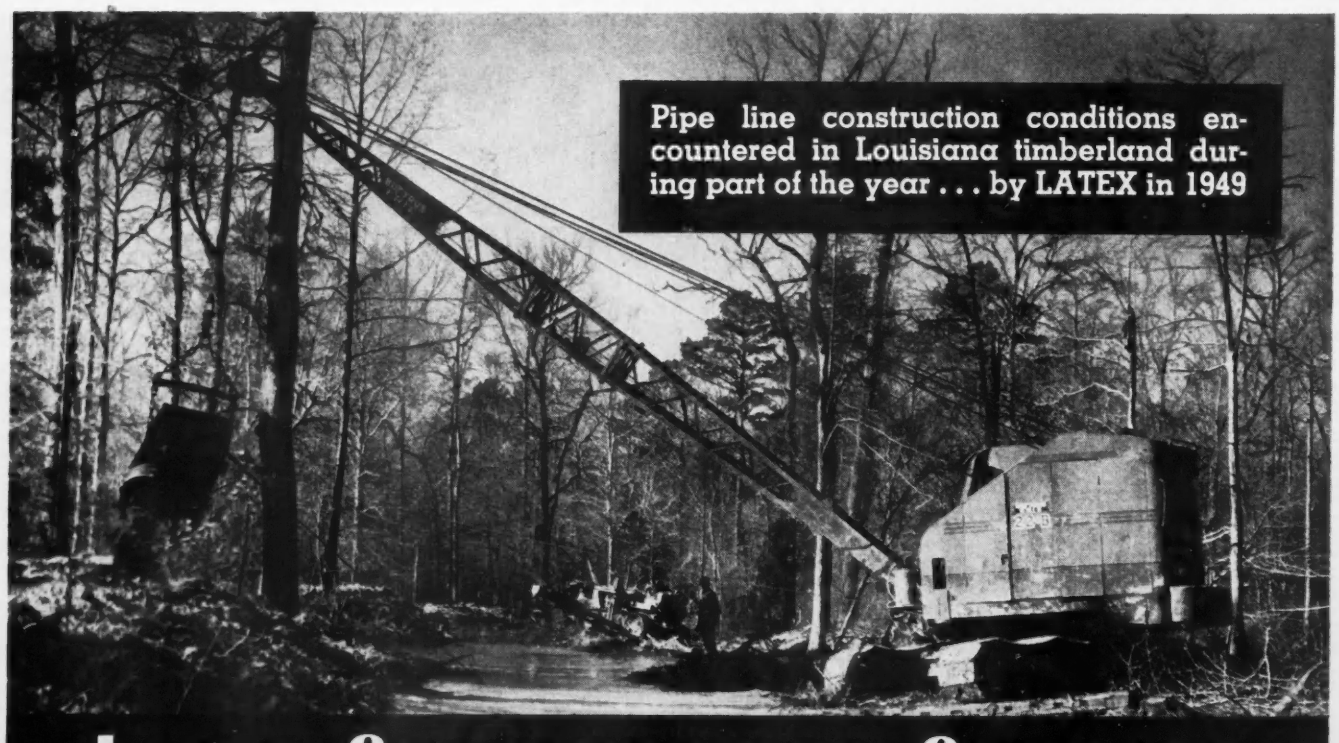
Another products line extension was announced by Phillips Petroleum Company. This 155-mile extension will complete the originally planned Borger, Texas-to-Denver line, which was built as far as LaJunta, Colo., in 1947, but never finished because of material shortages.

Table Includes Projects Planned, Contracts Awarded, and Spreads or Entire Projects Completed Since the February 1 Issue of WORLD OIL

COMPANY	Origin and Terminus	Length, (Miles)	Pipe Size, (Inches)	Daily Capacity (Barrels Cu. Ft.)	REMARKS
CRUDE OIL LINES					
Farmers Union Central Exchange, Inc., Shannon Oil Corp., & Mule Creek Oil Company.	Murphys Dome fld., Hot Springs co. to Stanolind's line at Kirby, Wyoming	5	4	.....	Permission for construction granted by Wyoming Public Service Commission in January.
General Petroleum Corporation	Gooseberry fld. to Grass Creek fld., Wyoming	14	4	.....	Completed early in February.
Interprovincial Pipe Line Co., Ltd.	Edmonton to Regina, Canada	450	20	.....	Canadian Bechtel, Ltd. & Fred Mannix & Co., Calgary, will start about first of March.
Interstate Oil Pipe Line Company.	Bude fld., Franklin co., Mississippi	7½	4	.....	Gathering system completed Jan. by Clyde A. Hust, Laurel, Mississippi.
	Humble gasoline plant at Opelousas to Interstate's main line near Sunset, Louisiana	7½	3 & 4	.....	Completed in Feb. by Townsend Construction Co., Bunkie, Louisiana.
	Athens fld., Claiborne Parish, Louisiana	5½	4	.....	Gathering system completed in Jan. by J. C. Moore, Magnolia, Arkansas.
Mid-Valley Pipeline Company	Mayersville to Oakland, Mississippi	111	22	150,000	Started in Feb. by Associated P.L. Contractors, Inc., Houston.
	Oakland to Clarksville, Tennessee	222	22	.....	Eastern Construction Co., Dallas, to start by first of Mar.
	Clarksville to Elizabethtown, Kentucky	111	22	.....	Britton Construction Co., Ft. Worth, to start about first of March.
	Elizabethtown to Hebron, Kentucky	111	22	.....	Started in Feb. by H. L. Gentry Construction Co., Jackson, Michigan.
	Hebron to Lima, Ohio	120	20	140,000	Mahoney Contracting Co., Mt. Pleasant, Mich., to start about March 1.
Naph-Sol Refining Company	Kimbell Lake fld., Newago co., to Muskegon, Michigan	26	6	.....	Scheduled for March completion by L. R. Young Construction Co., Olney, Illinois.
	Paris fld., to Woodville, Michigan	12	4	.....	Planned for early 1950 construction by L. R. Young Constr. Co.
PRODUCT LINES					
Phillips Petroleum Company	La Junta to Denver, Colorado	155	6	8,000	Planned for 1950, Line is extension of Borger-La Junta line, and will be owned 85% by Phillips and 15% by Shamrock O&G Corporation.
Salt Lake Pipe Line Company	Boise, Idaho to Baker, Oregon	120	8	.....	Will be started Spring of 1950. 8-inch will be built by Morrison-Knudsen Co., Inc., Macco Corp., & Bechtel Corp., San Francisco; 6-inch by Pacific Pipeline & Engineers, Ltd., San Francisco. Line to be extension of 8-inch Salt Lake-Boise line just being completed.
	Baker to Pasco, Washington	120	6	.....	
Santos Jundiai Railroad	Santos to Campinas, Brazil	41	10	.....	To be built in 1950 by Williams Bros. Corp., Tulsa. Two lines will be parallel between Santos and Sao Paulo. 18-inch will be designed to carry heavy fuel oil or crude. Project will cost $9½ mln.
	Santos to Sao Paulo, Brazil	30	18	.....	
NATURAL GAS LINES					
Algonquin Gas Transmission Company	Lambertville, N. J., to Boston area	276	.....	250 mm.	Application to FPC in Jan. Project would supply New England states from Texas Eastern Transmission's proposed line. Would include a compressor sta. at Middletown, Conn.
	Laterals from proposed Lambertville-to-Boston line	492	.....	.....	
City of Charlottesville	Virginia Gas Transmission's authorized metering sta. near Doylesville, Va., to City's existing system.	14½	6	.....	Planned for 1950 construction.
Michigan Consolidated Gas Company	Loop from Austin storage fld. to Detroit, Michigan	140	24	.....	Application to FPC in January.
	Austin storage fld. to Lincoln-Freeman storage fld., Michigan	30	24	.....	Application to FPC in January.
Mississippi River Fuel Corporation.	Installation of 7 new compressor stations of 27,000 hp in Ark., La., Mo., and addition of 5,000 hp in 2 authorized stations.	.....	.....	.....	FPC application amended in February.

Pipe Line Construction—Continued

COMPANY	Origin and Terminus	Length, (Miles)	Pipe Size, (Inches)	Daily Capacity (Barrels Cu. Ft.)	REMARKS
New York State Natural Gas Corporation	Company's 20-inch line at Dryden to Albany, N. Y.	164	.....	.....	Application to FPC in January.
	Dryden to Tioga co., Penn., storage fld.	56	.....	.....	Application to FPC in January. 7 miles and 5000 hp will be installed in another storage fld.
	Loop from Greene co. compressor sta. to Westmoreland co. compressor sta., Pennsylvania	53½	16	.....	Application to FPC in January.
Niagara Mohawk Power Corporation.	New York State Nat. Gas Corp.'s proposed sta. in Onondaga co. to Co.'s system near Syracuse.	16	14	4.1 mln.	Authorized by FPC in February.
	Montgomery, Schenectady & Albany counties, N. Y.	15⅜₁₀	.....	.....	Application to FPC in Jan. Would connect with N. Y. State Nat. Gas Corp's. line at 4 points.
	Oneida & Herkimer counties, N. Y.	10⅛₁₀	.....	.....	Application to FPC in Jan. Would connect with N. Y. State Nat. Gas Corp's line at 2 points.
Natural Gas Service Corporation	Transcontinental's Tex.-N. Y. line at Buckingham to Richmond & Hopewell, Va.	92	.....	80 mln.	Application to FPC in Jan. Line would also serve Petersburg, Va. Estimated cost $2,450,000.
Northern Natural Gas Company.	Loops between Texas Panhandle and Minnesota	442	26	140 mln.	Approved by FPC in Jan. Contracts were let before approval and were listed in Feb. 1 issue.
	Loop from Garden City to Bushton, Kansas	155	20	.....	
Panhandle Eastern Pipe Line Company.	Loops between Tuscola compressor sta., Ill. and Detroit	170	.....	250 mln.	Application to FPC in Jan. Project includes additiona 16,000 hp in existing stations. Facilities designed to handle gas from Trunkline Gas Supply's proposed La.-Ill. line.
Plains Natural Gas Company	Gathering system in Hugoton fld., Okla. Panhandle	78	4 to 24	.....	Completed in Feb. by Arey-Phillips Constr. Co., Dumas, Texas.
Roanoke Pipe Line Company	Virginia Gas Transmission Corp.'s line at Gala to Roanoke, Virginia.	30	8	.....	Authorized by FPC in Feb. Estimated cost, 596,800.
Southern Counties Gas Company.	Santa Monica to Malibu Beach, California	5	4	.....	Scheduled for April completion by Signal Pipe Line Construction Company, Los Angeles.
Southern Union Gas Company	Distribution system in Albuquerque, N. M., area	13	4 to 14	.....	Started in Jan. by Delmer M. Spafford, Farmington, N.M.
Tennessee Gas Transmission Company.	Buffalo, N. Y., to N. Y.-Mass. state line	303	26	250 mln.	Amended application to FPC in Feb. 26-inch line to be extension of authorized Ky.-Buffalo line. Project also includes installation of 42,000 hp in 7 new compressor stations, and 69,600 hp in existing or authorized stations. Capacity of system would be expanded to 1,310 mln. Estimated cost, $118,644,000.
	Loops on TGT line between San Salvador fld, Texas and Buffalo	787	24, 26, 30	.....	
	Supply laterals	75	.....	.....	
Texas Eastern Transmission Corporation.	Loop from Lebanon to Lancaster, Ohio	126	26	.....	Completed in Feb. by Associated Pipe Line Contractors, Inc., Houston.
Transcontinental Gas Pipe Line Corporation.	Demopolis, Ala., to Newnan, Ga.	206	30	340 mln.	Except for river crossings, completed in Feb. by Midwestern Constructors, Inc., Tulsa.
	Spartanburg, S. C., to Spray, N. C.	202	30	.....	Started in Feb. by R. H. Fulton & Company, Lubbock, Texas.
	Spray, N. C., to Falls Church, Va	196	30	.....	Started in Feb. by O. R. Smith Contracting Corporation, Ft. Worth.



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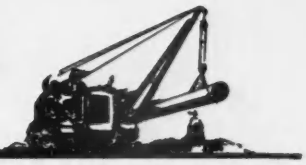
PIPE LINE HINTS



$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas

HOW TO—Handle Heavy Equipment

There is a continual need for lifting and hauling equipment around any large pipe line pumping station. It is particularly useful to have a versatile hoist when expanding or replacing part of the station system.

This converted farm tractor replaces the conventional truck with a gin pole in the rear and a winch hoist. Not only does the tractor perform the lifting and moving jobs about the station, but the gin pole in front of the vehicle makes it easier to position the object being lifted or moved.

The tractor frame is extended about 20 inches in front of the radiator by bolting to the tractor a long U-frame made of six-inch channel iron. A power-driven winch is mounted on this extension and driven by a chain-drive (shown on far side of tractor) connected to a power takeoff from the tractor's transmission. Rod extensions from the winch to the driver's position make it possible for the driver to control the brake and clutch of the front-end winch.

The gin pole is mounted on top of the channel iron frame and supported in place by steel rods extending from the peak of the A-frame mast back to the tractor axles. This converted tractor facilitates placing valves and other heavy equipment into difficult places. The characteristics of the vehicle make it extremely useful in getting around the station in off-the-road places.

HOW TO—Secure Joint Protectors

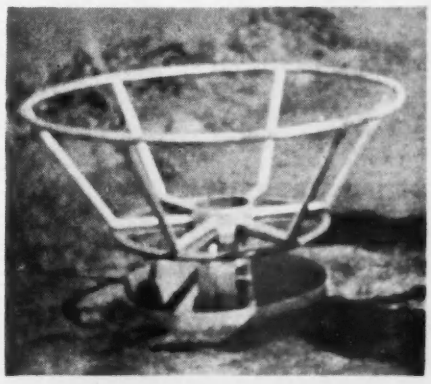
The addition of a river crossing sleeve at the joint of large pipe lines throughout that section of pipe traversing a river or stream is a common practice. A difficult operation is that of placing half of the sleeve around the weld so that it fits snugly against the pipe.

One of the simpler methods of insuring a tight fit is illustrated. By employing a hydraulic jack and short section of one-half inch chain, the river crossing sleeve can be drawn up tightly around the line. The underside section is set in place and held against the line while the chain and jack are positioned on top of the line. When the sleeve is tight against the pipe, it is tack welded. The top section is then slipped under the jack which remains on top of the line. The jack bears down on the upper section of the sleeve to press it into the place where it is tack welded, after which, a filler bead is run around the entire sleeve. A finish bead completes the weld.

HOW TO—Increase Leverage On Scraper Valve

Because of infrequent use, the gate valves installed in the line scraper trap system are sometimes difficult to open and close. This is usually the case when the valve must be operated in a hurry. Aiding the situation somewhat is this innovation which permits two men to exert considerable pressure on a large valve in the scraper trap system.

The valve stem extension is made of large pipe placed in the middle of a section of 30-inch pipe which serves as a casing around the upper part of the valve. Spokes of one inch pipe extend from the upper end of this stem extension, and a rim welded around the spokes connects them in a wheel.



Each spoke is extended upward at an angle of about 70 degrees. They are approximately two feet long and terminate at another but larger pipe hoop. This larger diameter hoop provides a considerable leverage on the valve stem which one man could hurriedly operate.

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HOW TO—Improve Cleaning Machine

Laying operations are speeded by one contractor by increasing the usefulness of the pipe cleaning machine. This view, taken from the top of the dope wagon, shows the cleaning machine in full operation. A burlap sleeve is wrapped around the pipe and attached to the back of the cleaning unit.

Dope is continually pumped through the flexible line shown to the burlap sleeve. The dope discharges into a wide canvas sling which distributes the dope to the burlap. As the machine proceeds down the line, dragging the burlap sleeve, it not only cleans the pipe, but also dopes it. The side-boom tractor lifting the pipe ahead of the cleaning machine also pulls the dope wagon.

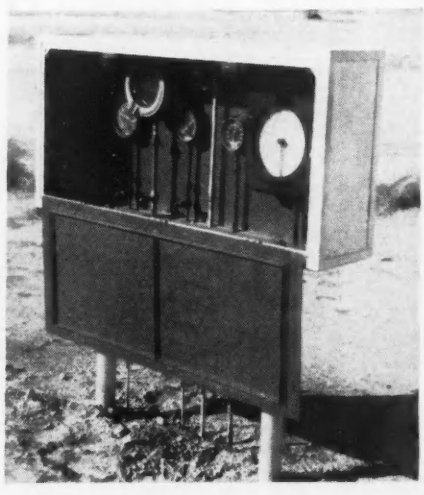
The cleaning machine is equipped with a two-inch pipe railing around the engine and frame to aid the operators in handling the unit as well as to prevent them from getting caught in the chains and sprockets. The two men following the machine can hold on to the rod extension at the rear of the cleaning machine when going over rough terrain.

HOW TO—Protect Station Gauges

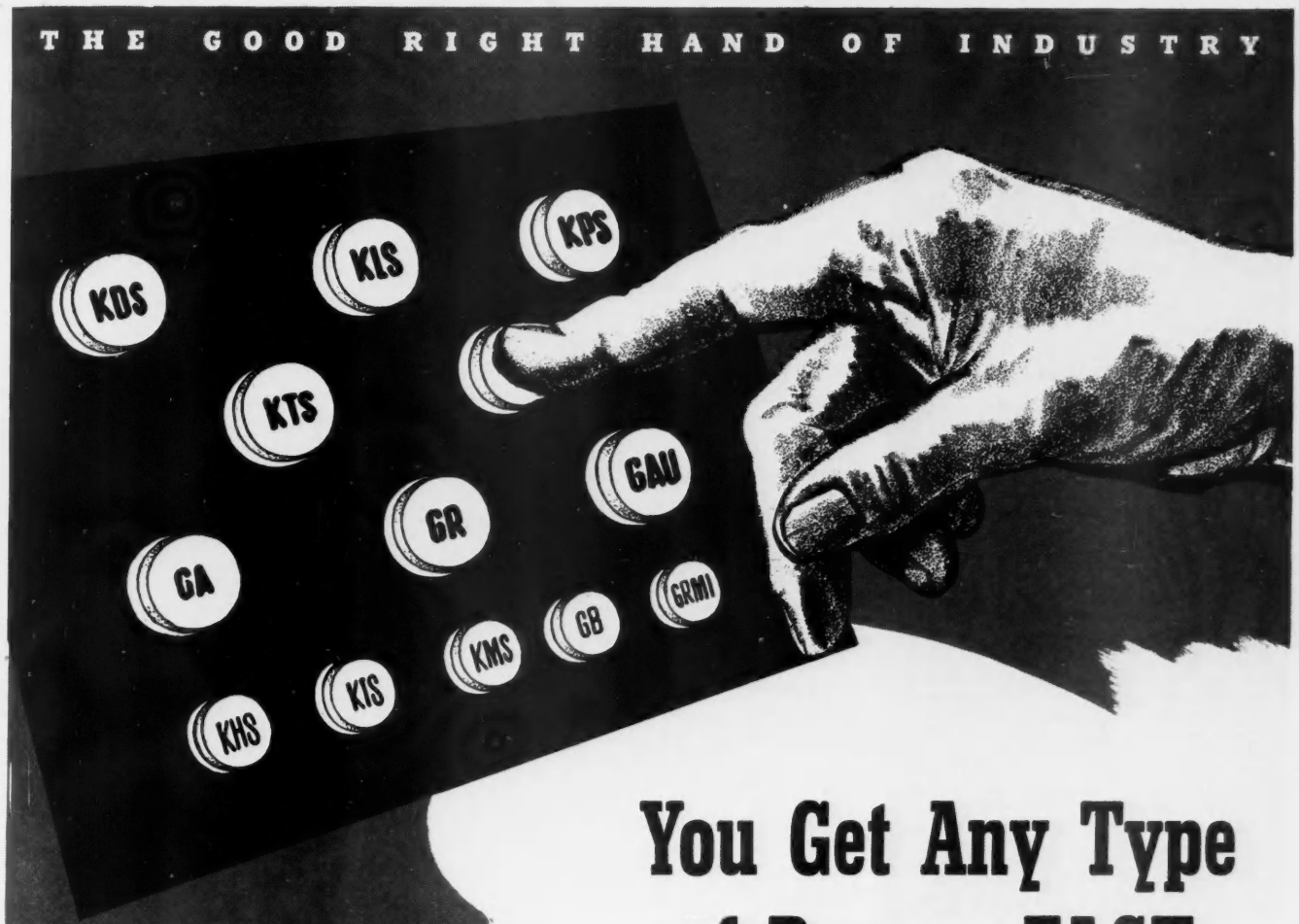
To assure that pressure gauges, recording meters and mercury type shut-off switches will not be tampered with, and to protect the equipment from wind-blown sand or rain, the field department of one crude oil pipe line company has found it of particular value to enclose such instruments in a specially designed enclosure which can be closed tightly and locked when the exposed pipe line pump is not operating.

A sheet steel cabinet reinforced with angle iron corners is mounted atop a pair of pipe legs about 30 feet from the pump. All lines are brought up underneath the cabinet and the gauges are mounted in orderly fashion along the back of the enclosure as shown. The door is hinged at the bottom so that when opened it will drop down out of the way, exposing all instruments to the operator.

The installation is one which can be adapted to numerous outside pumping stations, where the size or importance of the pump may not warrant the construction of an entire building. Reduced maintenance and checking of instruments thus protected will repay the initial cost of the enclosure.



THE GOOD RIGHT HAND OF INDUSTRY



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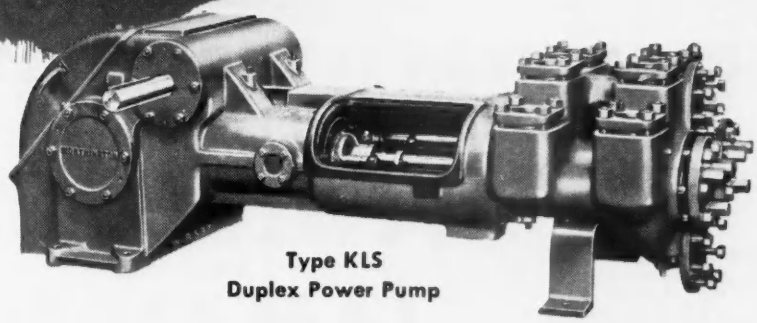

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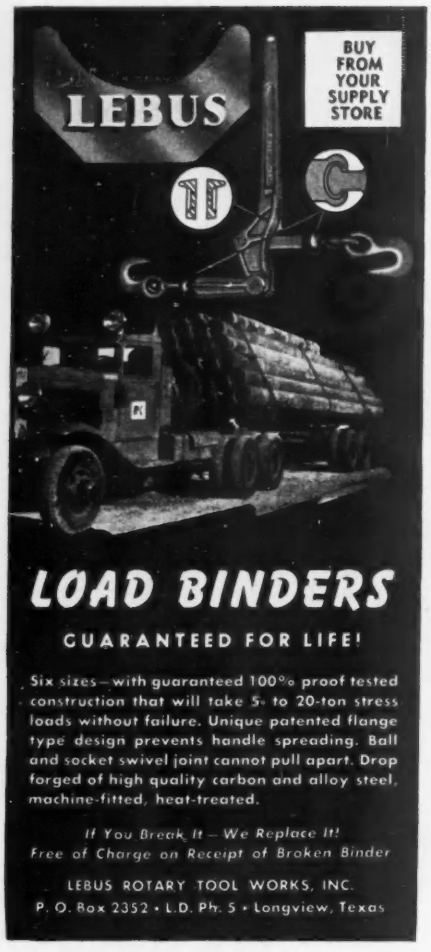
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HOW TO—Extend Range of Gin Pole

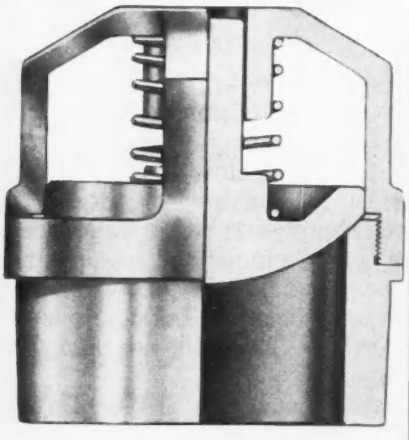
There are numerous construction applications where an extremely long lifting boom is needed. The effective lifting range of the ordinary truck-mounted gin pole can be extended considerably by this simple method. In the case illustrated, a pipe line manifold was being constructed, and it was necessary to lift the heavy gate valves to the middle of the excavated area.

A 40-foot section of ten-inch line pipe was anchored firmly at the front of the truck bed by chaining the pipe to the headache post. The truck winch line was then attached to the long pipe section at a point several feet beyond the end of the gin pole. An eye welded to the long pipe prevented the chain from slipping.

The heavy valve being lifted was attached to the end of the long pipe by a six-foot piece of heavy chain. As the truck winch was taken in, the 40-foot joint raised up at the far end, thereby lifting the valve off the ground. The truck was then backed carefully up to the edge of the excavation and the valve was lowered exactly in place. The gin-pole extension was again hoisted and the truck moved to get another valve. When this job was completed, the long joint of pipe was placed back into the pipe yard for further use.

Style No. 106

L-K All Metal CAGE TYPE PUMP VALVE



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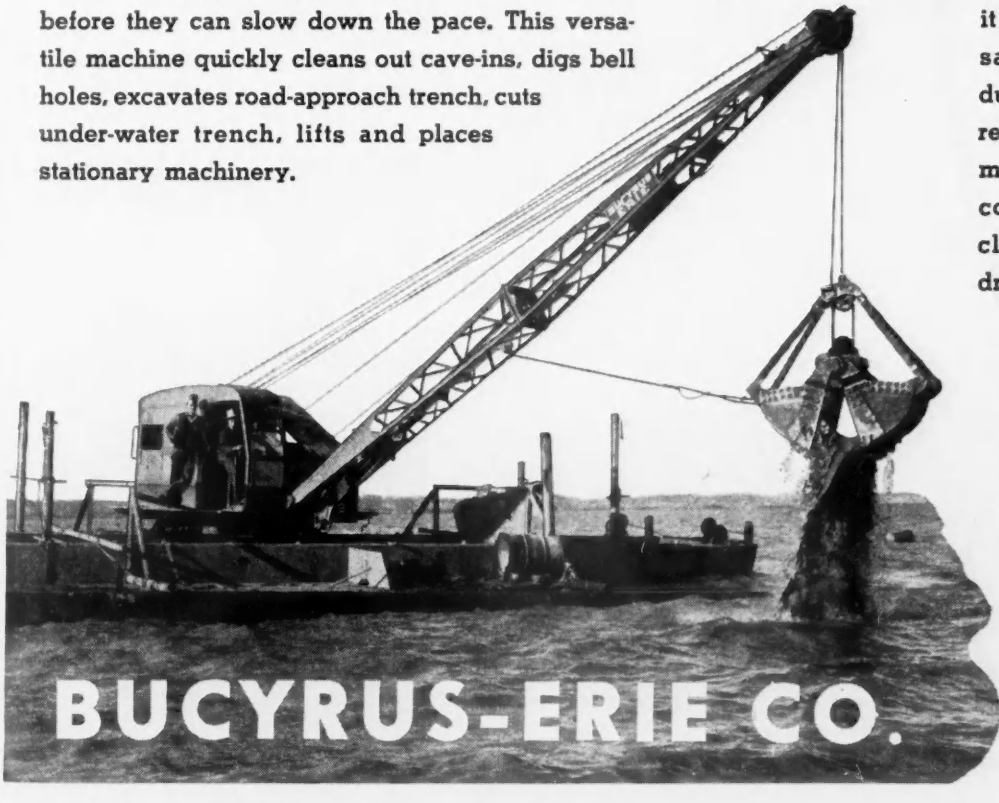

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HOW TO—Rotate Triple Pipe Joint

When large diameter pipe is being welded in the field, considerable time may be saved and the quality of the weld insured by rotating the pipe for the welder. As many as three joints may be handled by one man equipped with this simple, effective pipe turning tool. By triple-jointing the pipe in the field before it is added to the line, a minimum of welds need be made with the pipe stationary. In making such line welds, it is necessary for the welder to lie on his back when making the bottom bead, a difficult position in which to weld, and also one that adds to welding time.

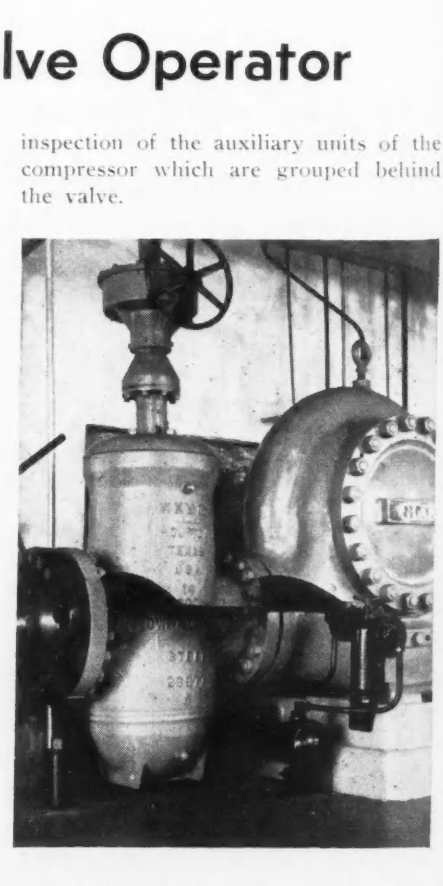
The enlarged pipe tongs illustrated are an ordinary set of tongs equipped with a chain for the large diameter pipe, with the exception that an extra long handle has been added. This handle is a ten-foot section of two-inch pipe, tapered down to a 1¼-inch pipe which affords the tong man a firm grip. As the welder puts on a bead, the tong man slowly rotates the pipe which rolls on supporting blocks. In this manner, the welder always works from a standing position where the work is located at a convenient height. An inspector can carefully look at a previous weld at the same time to eliminate having to crawl under the pipe to make the inspection.

HOW TO—Guard Valve Operator

Certain types of valves used on "big inch" lines are so large that their overall height puts the valve hand wheel out of reach of the operator, and some type of stand must be provided to enable him to wheel the valve when hand closure is required.

One gas pipe line company makes a wide step out of special steel tread, forming it with two flanges which fit closely within the companion flanges of the valve body. Holes in these flanges are drilled to match the bolt-hole circle of the valve, and the corresponding bolts retracted so that the step can be slipped into place, the bolts returned, and the nuts tightened down to hold the step securely and firmly in place.

The non-skid step is painted black, to differentiate it still further from the bright aluminum color of the valve body, and thus emphasize the working area. Set at the proper height to bring the hand wheel at waist level for the operator, the step is high enough so that it does not interfere with floor cleaning, or inspection of the auxiliary units of the compressor which are grouped behind the valve.



Oil Possibilities in the *Philippines*

By JUAN S. TEVES
Senior Geologist, Bureau of Mines, Manila, Republic of the Philippines

THE PHILIPPINE ISLANDS are in the interesting position of bridging a gap between islands to the north and south where important oil production has been developed. The Philippines are also strategically located near a potentially huge market and could conceivably play a vital oil supply role should there be another war. To encourage exploration, a very liberal oil law has recently been passed.

THE location of the Philippine Islands in the West Pacific is a great potential asset insofar as oil is concerned, as the geology of the areas bordering this great Pacific Basin has certain features in common recognized by various authorities. These areas lie in a zone that extends from the Americas to Alaska on the north; Sakhalin, Japan, Formosa, the Philippines and the East Indies.

Island Chains

On the west side of this Basin the zone is made up of the several island chains arranged in arcuate pattern. These are the Kamchatka Peninsula together with the Kurile Islands; Sakhalin and the Japanese Islands; the Ryu Kius to Formosa; Formosa through the Philippines to Borneo in the East Indies —all forming arcs with the convex sides toward the ocean on the west. It has been noted that these islands possess petroleum-bearing rocks and that in the Philippines, which represent a link in this chain of islands, are found not only petroleum-bearing formations, but also oil and gas seeps and bituminous rock deposits. This makes the position of the Philippines interesting as it bridges a gap between the islands to the north and those to the south where important oil production has been developed.

In studying the oil possibilities of the Philippines, authorities invariably have looked southward to the East Indies, site of a number of commercial oil fields, where very intensive geological studies have been made and, a most important factor, where it is believed the Philippines have closer geologic affinities because of their close geographic location. Students of the geology of the East Indies and of the Philippines have recognized striking similarities in the tertiary geology of the two areas. In the first, attempts have been made to analyze the regional tectonic positions of the Tertiary Basins. From the geotectonics point of view it is an area of great complexity and interest. Major tectonic elements have been recognized. Schuppli has presented them as the old Gondwana Continent, the Asiatic Continent, and the Pacific block.

Fold-Arcs

Between these tectonic blocks, and in some places within them, lie the young fold-arcs or orogenes of the archipelago, one of which follows the outer edge of the Asiatic continental block called the circum-Asiatic Tertiary orogene which has arisen from the geosynclinal zone representing part of the "Thethys" which has been traced from the Alps over the Caucasus and the Himalayas and on through Japan.

This orogene shows two distinct geanticlinal arcs. The inner is characterized by young volcanism, a main phase of post-Pliocene folding and locally with reference to Java and Sumatra, as northward-directed tectonic movements. The outer arc shows no young volcanism. Its main folding is Miocene in age and the direction of the tectonic movements is opposed to that of the inner arc.

The arc comprising the more recent folding lying between Australia and the Pacific block embrace the Tertiary folds

of New Guinea and Halmaheira. This is called the Australo-Pacific orogene and is similar to the circum-Asiatic in geologic position and in tectonic structure; that is, it also possesses a structural bilateral symmetry. From Halmaheira it extends northeastward into the submarine ridges and island rows of the Pacific.

Intra-Asiatic Orogenes

The Borneo geosyncline areas are near the edge but within the Asiatic continent. They are called the intra-continental or intra-Asiatic orogenes and differ markedly from the circum-Asiatic in that these basins have much thicker sections and do not show any indication of intensive later volcanic activity which characterizes the other. They do not possess the bilaterally symmetrical structure, but rather are characterized by a centrally situated geanticline.

The oil fields of the East Indies are in areas underlain by tertiary sediments. In Sumatra production appears to come from the Upper Miocene to Pliocene beds; in Borneo to the north at Klias, oil production is from Pliocene beds, while to the east at Kotei it is found in beds of Miocene to Pliocene age. Production in Java is from the older Tertiary beds.

The most important oil fields are in a series of geosynclinal basins paralleling the northeast coast of Sumatra, the north coast of Java, and the east coast of Borneo, a belt which forms the prolongation of the oil fields of Burma. Nearly all East Indies oil is obtained from anticlinal structures.

In Japan most of the production is along the coasts of the Sea of Japan and, as in the East Indies, is from Miocene and Pliocene beds. This is also probably true as regards production in Formosa. There is, therefore, a general similarity in the ages of the producing horizons of these areas to the north and south of the Philippines.

This interesting geographic position of the Philippines, and the lack until recently of an adequate investigation of the petroleum possibilities of the country, has led to varied comments. There were some who doubted, and others who even denied altogether, the existence of oil, while the more optimistic were confident that oil could be produced in sufficient quantity to warrant exploration.

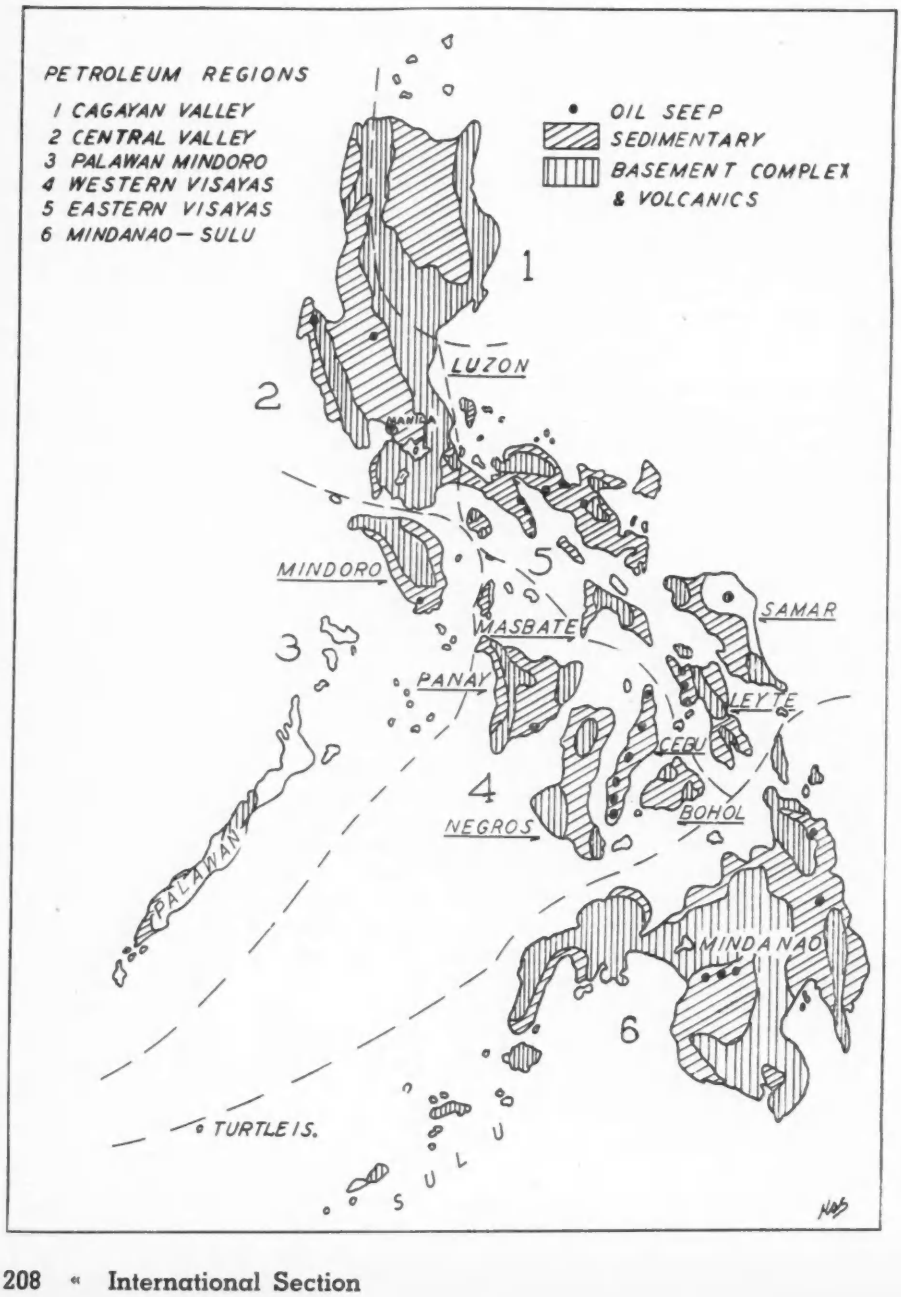
This much, however, can be said: oil is present in the Philippines and it was first mentioned by Abella, a well-known Spanish geologist, in 1890. He saw natives at Dumarao and Libracao, Capiz, get petroleum from impregnated clay. He cites locations in Cebu—Asturias, Toledo and Alegria—where oil was obtainable and which were known to the Spaniards in 1888. Because, probably, of its limited use at the time, no efforts were made to develop it, even for local consumption. Some years later, however, attempts were made to develop production. In 1896 Smith, Bell and Company drilled two tests 50 meters apart which reached depths of 244 and 344 meters, respectively. Both yielded small amounts of oil but work was abandoned due to an uprising the following year.

In 1936 several wells were drilled in central Cebu to about 150 meters and all reported good oil shows. In 1938 the National Development Company drilled a well in Barili. The Far East Oil Company, now known as the Philippine Oil Development Company, drilled a well at Daan-bantayan in 1940 but the war caused its abandonment after it had reached a depth of 8000 feet. In 1947 the same company drilled another test near the first and it was abandoned at 9955 feet after reaching the basement rocks.

It has been known since 1890 that petroleum exists near Villaba, Leyte. Two wells have been drilled in northwestern Leyte, one in the Balite area and the other to the east of the Calubian anticline, the last reaching a depth of some 350 meters and producing a small quantity of oil.

1906 Test

In the Bondoc Peninsula of Quezon (Tayabas) Province there are several seeps described by Pratt. The first well was drilled in this area in 1906 followed by eight additional shallow wells, all reporting good oil shows. Two shallow tests were drilled in 1910 by Americans on the strength of the reported seeps. The Richmond Oil Company drilled four

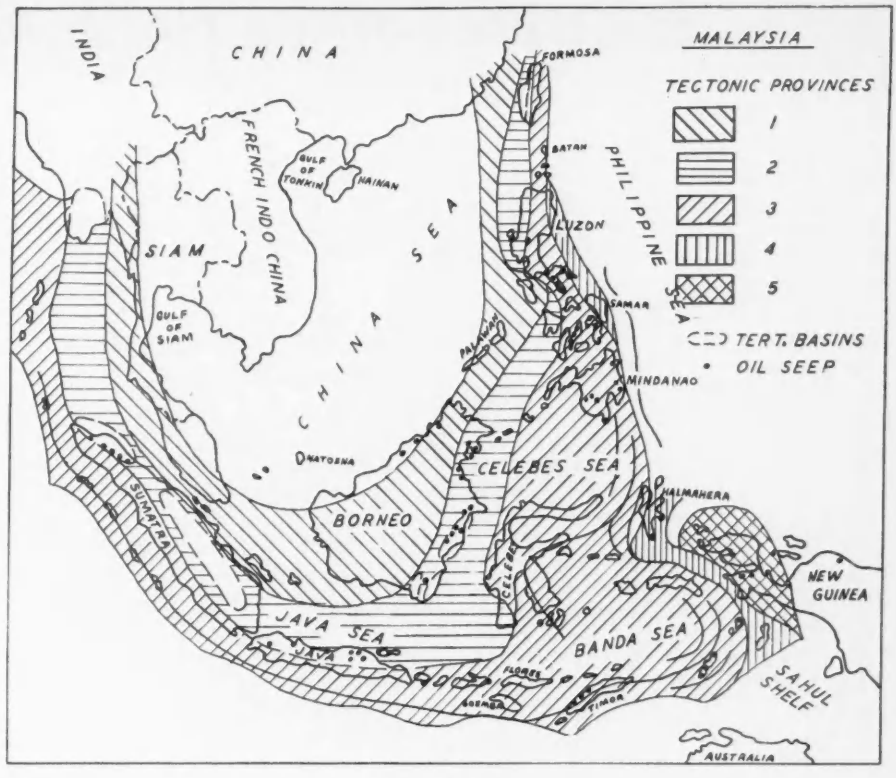


wells between 1921-25, one reaching 5000 feet.

The Philippine Oil Development Company drilled five holes in 1937-38 and in 1948-49 one well was carried to 5500 feet. Drilling difficulties were encountered in all the tests.

The Pidatan field in Cotabato is one of the few localities in Mindanao where oil has been found. Some oil also has been reported in the southern part of Mindoro, from Anda on the west coast of the Lingayan Gulf in Pangasinan, from southwestern Isabela Province near the border of the Mountain Province, and from localities in Camarines Sur. The accompanying map shows the occurrence of oil seeps as well as the sedimentary formations which may be the source rocks for oil.

The work of the Petroleum Survey, the most extensive investigation of the petroleum possibilities in the Philippines, was conducted between 1939-41 under the direction of Grant W. Corby and as a result of the information obtained it has been found necessary to revise the geologic map of the Philippines. This survey covered an area of approximately 12,560,000 hectares, or 42 percent of the total land area of the Philippines. It was made in close cooperation with the Bureau of Mines, the director serving as consultant to the organization with members of his staff detailed to assist in the work. A number of qualified American experts also worked with a staff of Filipino engineers and assistants. A complete foraminifera and paleontological laboratory was organized and placed in operation and eight survey parties assigned to the field. Detailed surveys were made in Tarlac, Leyte, Cebu and Panay with extensive reconnaissances in other provinces.



Survey's Accomplishments

Perhaps the most valued accomplishment of this survey was the building up of detailed standard sections of the Tertiary and the determination of the fossils characterizing each horizon; the regional correlation of the formations involved; and the equivalent of the oil bearing horizons of neighboring countries including Japan and Taiwan (Formosa) on the north, and the East Indies on the south. These horizons have been recognized in the Philippines. Favorable geologic structures were found to exist and on these bases prospective oil areas were then located in different sections of the Philippines.

Another valuable contribution of the Petroleum Survey conducted just prior to the war is the finding which made possible the extension of the major tectonic provinces of the East Indies to the Philippines. Five such provinces have been delimited based on the geological history, stratigraphy, geotectonics, volcanics, and geophysics.

A brief summary of the peculiarities of each as shown in the accompanying geotectonics maps follows:

Province 1. This province is mainly characterized by relative orogenic stability, at least since Mesozoic time. Occasional submergence during times of broad Tertiary transgression has been noted. It is considered part of an older continental shelf, at least in Mesozoic and Tertiary times, which are believed to have furnished sediments to the south and east in the East Indies during the latter period.

Province 2. This made up a bed of disconnected basins which subsided without interruption during the Tertiary. They were folded at the close of the Pliocene. They comprise sediments about some 9000 meters thick, with shallow to brackish water deposits, but occasionally include those of continental origin.

Province 3. This province is the most active orogenically. Its main features include: active volcanoes, maximum negative anomalies and submarine deeps in the East Indies, angular unconformities in the Miocene, and considerable seismic activity.

Province 4. Practically undisturbed in the Tertiary.

Province 5. This province appears to have some of the characteristics of Provinces 2 and 3 and is limited to New Guinea.

The above tectonic provinces are essentially similar to the Tertiary orogenes of Schuppli. They are presented as they show their trends in the Philippines. Producing areas in the East Indies can be seen to extend into the Philippines. From the foregoing it would appear that the Philippines offers excellent opportunities for developing commercial oil production.

A mapping program is presently being carried out by the Bureau of Mines and all new data brought in from the field in the course of geologic surveys are plotted. To date the area of Tertiary sedimentaries as shown in the accompanying map cover approximately 14,402,000 hectares, which is a rather large prospective terraine for petroleum exploration. It also shows definitely the closing of the gap in the chain of islands in this part of the Pacific with Tertiary basins.

The great oil consumption during the war and the increasing peacetime demands for this product make it important that new sources be discovered and the Philippines, which recently adopted a very liberal oil law, has many characteristics which should result in the development of important oil reserves close to a potentially large market which today is supplied from oil resources which are far distant and subject to many viscissitudes.

Structures of the Northwest Basin in Western Australia

By ERIC K. CRAIG
Consulting Geologist

THE base camp for geologic exploration in the Northwest Basin, Western Australia, is at Learmonths, on Exmouth Gulf. The camp was an American submarine base in 1942-3, with a protective Australian air field. The larger barrack used by the RAAF has been overhauled and made habitable for civilians. Culinary and auto maintenance departments are staffed by employes of Ampol Petroleum Company of Sydney. Mail and perishable supplies are flown from Perth, 850 miles south. Gasoline and heavy supplies are also transported from Perth, part way by train and 500 miles by truck; with a three weeks interval between ordering and delivery.

The Cape Range Dome

The Learmonth terrain is dominated by the 1000-foot Cape Range. The Cape is formed by a huge closed anticline and is surfaced along the crest by ferruginous pink, massive limestone of Middle Miocene age. The physiographic expression of the elliptical dome is a northerly tapering peninsula, 35 miles long and 12 miles wide. The maximum elevation, 1033 feet, occurs close to the structural crest. The east flank dips 8 degrees, the west flank 4 to 6 degrees. The central area has been dissected in both flanks; the east limb in nearly vertical walled gorges 300 to 600 feet in depth, with "V" bottoms. The more gently sloping west limb is incised to a depth of 100 to 300 feet. The massive pink limestone, which forms the surface over the central area, is 180 feet thick in the lower east flank. It is thinned by progressive erosion to 60 to 70 feet at the crest, in a reversed shingling arrangement. The erosion of successive lower beds, upflank, has formed low longitudinal ridges with the steep fronts facing the crest.

Miss Irene Crespin, Commonwealth Paleontologist, assigned the foraminiferal fauna from the massive pink limestone to the "f_1-f_2" stage of the Indo-Pacific classification, as arranged by the late Dr. Tan Sin Hok in 1939—the lower portion of the Middle Miocene.

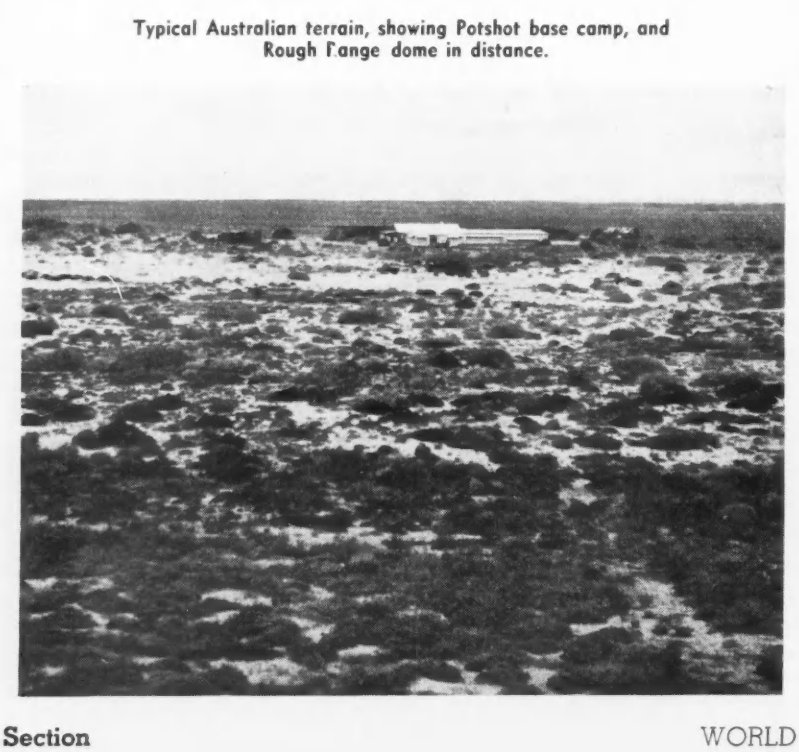
Underlying the massive limestone occurs a friable, limestone-cobbled marl yielding a mud-dwelling echinoid, tentatively classified as Conoclypeus. The cobbled marl is lenticular and the cobbles are not always present. The marl grades downward through 220 feet into a white, friable, granular limestone banded with discontinuous nodular flint. The granular limestone continues to the bottom of the deepest gorge, through a thickness of 200 feet. No fossils were collected from the granular limestone. Previous investigators have assigned it to Middle Miocene on faunal evidence.

The friable cobbled marl weathers readily to form caverns beneath the massive limestone cap—a popular daytime seista spot for kangaroos and wallabies. Cracks in the cap limestone, channel water to the porous, subjacent marl, forming solution sinks, crevices and potholes at the surface. From the air the surface looks smooth, but it is fairly rugged, even on foot. Jeeps can reach the top of the range from the south to within a couple of miles from the structural apex. In addition to the rough surfaced limestone, auto travel is made more difficult by irregular patches of dense scrub, the broken fragments of which can easily penetrate a new six-ply tire.

South and north of the central part of the elliptical dome, younger and thinner bedded, cream to white crystalline limestones emerge from the uplifted Pleistocene beach sediments to arch over the axis well down the south and north plunges. The younger limestone series is exposed in a unit section at an isolated outlier hill, called Mt. Lefroy, due west of Learmonth. The section exposed in the hill is 200 feet thick. There are two slight depositional breaks between the massive cap limestone and the superjacent thin-bedded, cream limestone. The breaks are represented by two 3- to 6-inch bands of pebbly laterite. Fauna collected from the top 25 feet of the Mt. Lefroy section were noted by Miss Crespin "This assemblage is typically 'f' stage and is referred to the horizon 'f_2-f_3.'" (In the Indo-Pacific classification "f_2-f_3" stage is younger than "f_1-f_2" stage; the former is referred to the upper part of the Middle Miocene.) The laterite depositional breaks evidently represent unimportant time intervals.

The Cape Range structure was too extensive and difficult of access to

Typical Australian terrain, showing Potshot base camp, and Rough Range dome in distance.



attempt to map by structural contours in the time available. Reconnaissance indicated at least 1000 feet of closure down to sea level. No evidence of faulting was noted. Detailed structural mapping of the Cape Range was instituted by Commonwealth geologists in May, 1949, and will be carried to completion.

The Rough Range Dome

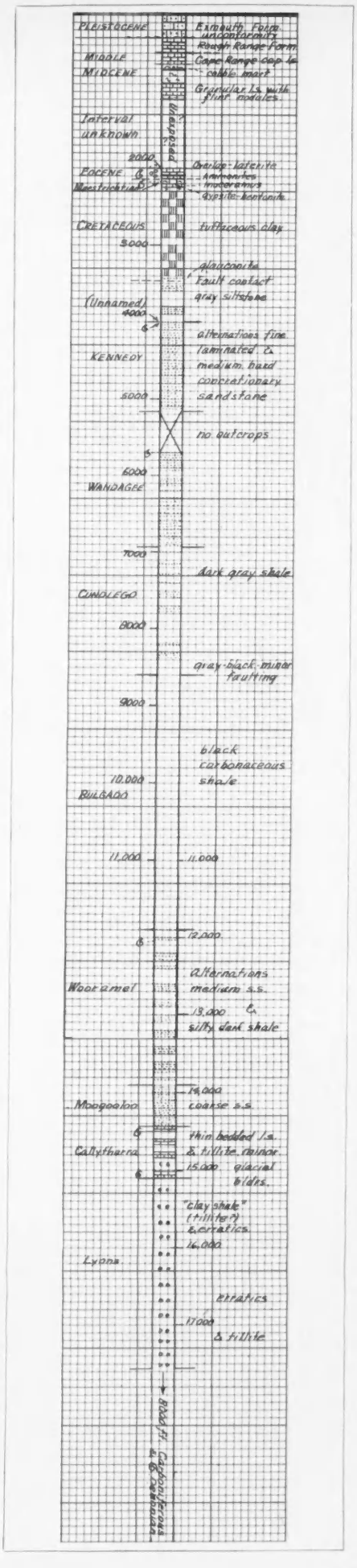
The Rough Range, so-called "textbook structure," is the topographic expression of an elliptical dome en echelon to the Cape Range anticline to the southeast. The apex of the dome is 384 feet above sea level and 12 miles due south of Learmonth. Reconnaissance disclosed the mildly dissected surface to be readily accessible by jeep and the critical area could be surveyed with the instruments and time available.

There are approximately 16,000 acres within the closed sea level contour, with the possibility of greater acreage extending to the 150-foot sub-sea contour, depending upon the position of the Dingo syncline axis. The synclinal axis is mantled in a wide, sand-duned trough with no outcrops across a distance of four miles. The apex of the Rough Range structure is ten miles by sandy road from sheltered Exmouth Gulf tidewater.

The oldest rocks exposed in the Rough Range contain the same fauna as found in the Mt. Lefroy section above the massive pink limestone of the Cape Range. The thickness of the exposed section aggregates 210 feet. The foraminifera from samples of the lower 170 feet are referred by Miss Crespin to the "f_2-f_3" stage of the upper Middle Miocene, correlating to the Mt. Lefroy section of the Cape Range. The limestone strata are thin bedded in the west flank, but grade into typical coral reef foreset structure in the east flank, 1½ miles distant.

From the top 40 feet of the Rough Range limestone the fauna were noted by Miss Crespin: "This assemblage, in the absence of Miocene zonal foraminifera, is tentatively referred to the Lower Pliocene." There is no depositional break between the two assemblages. It is possible that the Upper Miocene and Lower Pliocene faunas are closely related and the time interval in Australia is represented by a thinner stratigraphic section than in the East Indies.

Molluscan fossils, not too well preserved, from the top 40 feet of the Rough Range, were determined by Dr. Curt Teichert, Melbourne University, by genera only. "This is a typical assemblage of younger Tertiary age." Unfortunately, little work has been accomplished on younger Tertiary megafauna in Australia, owing to isolation



of the coastal areas where they may be found.

Overlapping the top 40 feet of the Rough Range limestone, and in abutment contact against the eroded lower coral reefs of the east flank, occurs an ill-bedded, ferruginous, brown sandy travertine, the Exmouth Formation. This formation mantles much of the Northwest Basin area. The composition varies from sandy travertine to calcareous sand and pseudo-stratified travertinized sand dunes. Where the base of the Exmouth is exposed, it consists of angular pebbles of the underlying limestone, a few milky quartz pebbles and spherulitic limonite. The sandy travertine is highly soluble, forming potholes and solution-sinks many miles in diameter. The weathered end product is a fine, reddish-brown sand, collecting in dune windrows so prominently displayed from the air between the Gascoyne River and Exmouth Gulf. There are no deep channels in the Exmouth formation from which the thickness can be measured. Elevations taken on progressive overlap of the Exmouth beds on the south plunge of the Rough Range Anticline indicate a local thickness of 250 to 300 feet. Water wells drawing from the sandy travertine are invariably too brackish for human use, although satisfactory for stock.

The flanks of the Rough Range dome dip 2 degrees east and 1 to 1½ degrees west. The syncline east of the structure plunges north to form the Exmouth Gulf, with the axis about eight miles east of the anticline.

The Giralia Range

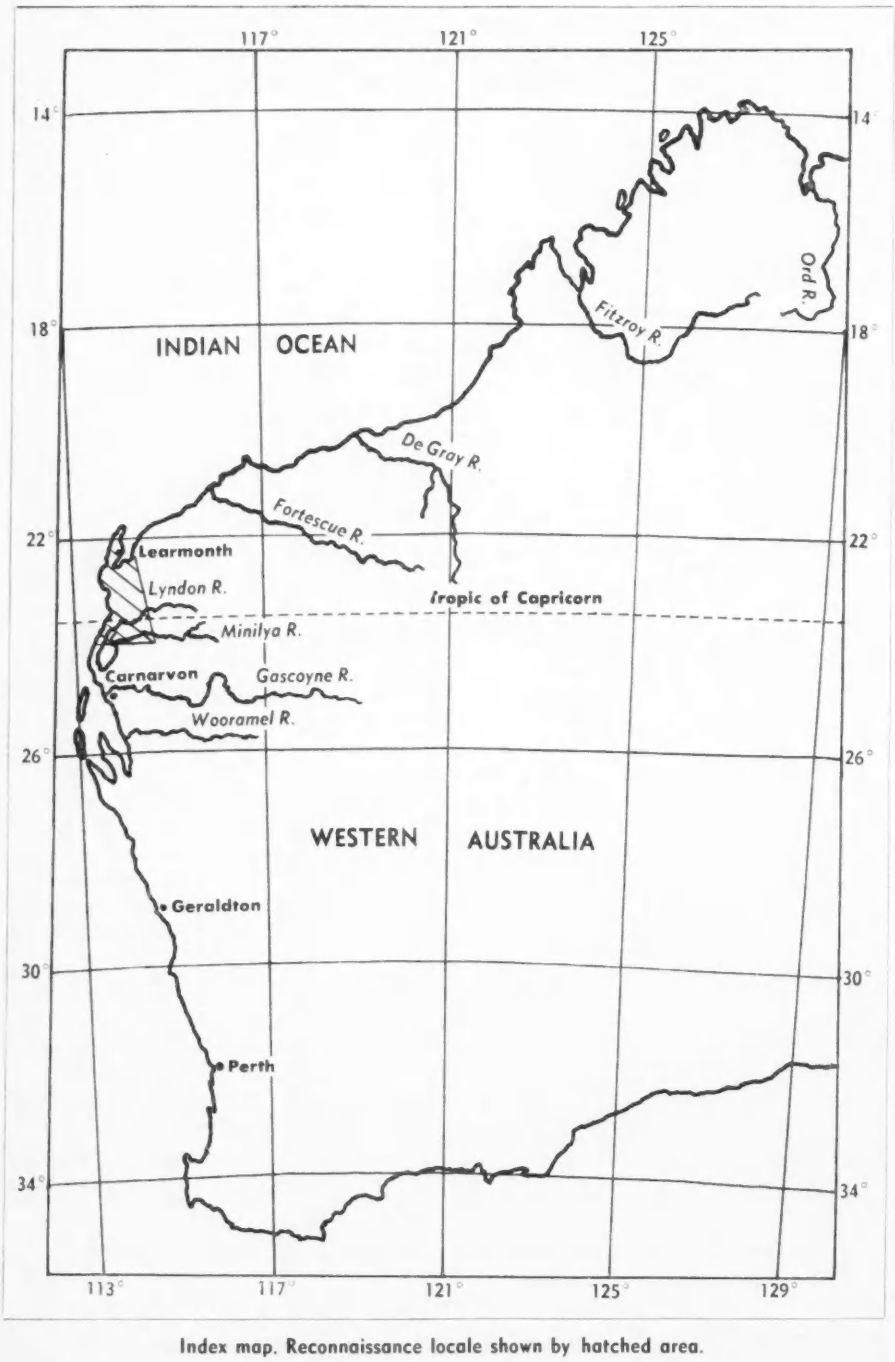
The Giralia Range is formed by a long, gently north plunging anticline, 15 miles east and south of the Rough Range. No definite structural closure was found in a survey extending for 48 miles south of the Exmouth Gulf; although there are two local areas where the plunge northward flattens for a mile or two, then again rises to the south. The local interruptions in the northerly plunge are due to transverse flexures in the fault-margined east flank; but with no measurable transverse flexuring in the west flank.

The west flank dips uniformly one degree. The east flank dips 1 to 2 degrees for a mile from the axis, then abruptly steepens to 30 to 50 degrees against a fault. Owing to low relief and shallow dissection, the actual fault plane is not visible. It is inferred from the abrupt steepening of the dip and a

Composite stratigraphic column of Northwest Basin, Western Australia.

linear arrangement of discontinuous, massive quartzite outcrops, close to and east of the steep dips. Microscopic examination of the quartzite by M. H. Johnstone, University of Western Australia, disclosed anhedral, inequiangular texture. The composition was dominantly recrystallized quartz, with minor accessories of well rounded rutile and zircon. The quartzite is believed to have been derived from siliceous solutions ascending along the fault channels from the shallow underlying rhyolitic tuff of the Cretaceous. The fault includes obvious normal displacement, with horizontal shift inferred from the sharply transverse flexured east flank of the anticline.

In the northern portion of the anticline, Miocene crystalline limestone and underlying marls arch over the axis. The crystalline limestone beds are separated from the marl by a discontinuous zone of laterite and laterite pebbles. The foraminiferal assemblage from the crystalline limestone was determined by Miss Crespin. It was identical with that of the Rough Range and Mt. Lefroy sections, testifying to contemporaneous deposition. The laterite zone appears to correlate closely with narrower laterite parting at the top of the massive pink limestone of the Cape Range. The massive limestone is absent at the Giralia Range, but the marl at both Ranges is contemporaneous. Miss Crespin's remarks on the foraminifera from both the crystalline limestone and marl "In addition to the larger foraminifera, the small rotallines and miliolines were studied separately. Forty-three specific forms were determined. These included 16 species recognized as index Miocene foraminifera among those described by Schwager from Kar Nicobar, by Le Roy from Java and Sumatra and other workers in the Netherlands East Indies; such as Koch, Scheffen and Thalman. The species described by Le Roy came chiefly from the Lower Palembang beds in Sumatra and are regarded as a phase of the Middle Miocene. They are figured in his 'Miocene Foraminifera from Sumatra and Java, Netherlands East Indies' Quarterly Journal of the Colorado School of Mines, Vol. 39, No. 3, 1944."



Index map. Reconnaissance locale shown by hatched area.

Ten megafaunal genera from the same Miocene crystalline limestones were determined by Dr. Teichert: "The assemblage resembles that from the Rough Range and is probably Miocene."

The Miocene-Eocene contact is based on a color change, from white to yellow, in the marl, and faunal determinations. There is no angular unconformity, or depositional break which can be recognized in the low relief. The Eocene appears to be absent farther south and it is probable that the faunal disconformity is represented by a gentle regional overlap of the Miocene from northwest to southeast.

Both the Miocene and Eocene marls contain mud-dwelling echinoids determined by Dr. Teichert as Cardiaster n. sp.; Hemiaster n. sp. and abundant grains of glauconite. Immediately below an horizon where the glauconite is concentrated to 50 percent by volume of the rock is found a fossil bed in tan colored marl. Dr. Teichert determined 21 ammonite and mollusc genera, mostly new species, from this bed. He refers the assemblage to Maestrichtian, Cretaceous age. Except for the concentration of glauconite, immediately above the amonite zone, there is no other horizon of demarcation betweeen the Eocene and Cretaceous. The mature relief of the region conceals the answer to the Eocene-Cretaceous relationship, as well as that between the Miocene-Eocene.

Cretaceous tan to cream-colored friable marl underlies the Eocene marl. Embedded in the marl and, in places composing 75 percent of the sediment, are plates and fragments of Inoceramus which attained a long dimension of 18 inches. The aragonite texture of the shell fragments is characteristic. The Cretaceous marls aggregate 120 feet in thickness, with thin limestone reefs intercalated in the lower portion. Underlying the marl, at invariably soil-mantled contact, occurs irregular patches of gypsite and impure bentonite. The bentonite grades downward into white, with vari-colored iron oxide staining, compacted, argillaceous, rhytolitic tuff. Marine deposition is at-

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AP-303

Geologist working in Cape Range gorge. Stratigraphy of the area is featured by massive, pink Middle Miocene limestone.

tested by abundant radiolaria. The tuff is massive, "punky," absorbent at contact with the tongue, and quite devoid of bedding. A thickness of 200 feet is exposed along the axis of the anticline. Water well records indicate a local thickness of 1200 feet of tuff, terminating in a bed of glauconitic sand.

The Giralia anticline is complemented on the east by a broad shallow syncline, mantled by Exmouth sandy travertine and sand dunes.

The Minilya River Section

The nearest location for study of the strata below the Cretaceous is the Minilya river section, 165 miles by road, southeast of Learmonth. The Cretaceous-Permian contact is faulted and the depositional relationship is obscured. The sedimentary succession of the Permian was pace-traversed from the faulted Cretaceous contact, 35 miles upstream to the Callytharra limestone series of the lower Permian. The textural sequence is shown on the accompanying "Compiled Stratigraphic Column." The column is compiled from the notes of the areas described above. After the writer's departure, Commonwealth geologists continued the Minilya section to the east. Dr. N. H. Fisher, chief geologist for the Commonwealth, advises that, instead of the down-faulted repetition of lower Permian beds, as previously published, they have found an additional 8000 feet of probable carboniferous and fossiliferous Devonian between the Lyons glacial deposits and the crystalline Pre-Cambrian.

The age of the Minilya river section has been determined as Permian from fossil evidence in published papers.[1]

The Kennedy sandstone division consists of massive, medium, concretionary sandstones with intercalated, laminated, fine to medium micaceous sands. Porosity and permeability are attested from the fact that the Kennedy sand is the principal water producing zone for the bores in the area which it underlies. The sandstone members in the Wandagee and Cundlego divisions are similar in type and qualities to the Kennedy. The Moogooloo division, just above the Callytharra, consists of compacted, well-rounded, medium to coarse quartzose sand with ferruginous matrix. It is highly porous and permiable.

The siltstones and shales of the Permian are fissile to hackly in fracture, micaceous, richly carbonaceous in Bulgadoo division. They should form effective structural seals for underlying fluids.

General Notes

The presence of the Mt. Lefroy-Rough Range "f_1-f_2" Miocene limestone resting on Eocene sediments at the Giralia Range testifies to the southeasterly overlap in Middle Miocene time. It is also evident that marine transgression, and subsequent regression, to the east and south occurred in Eocene time; with similar periodicity of diastrophism in Permian and Triassic-Jurassic time. It is therefore obvious that the post-permian section at the Rough Range dome, and still more at the Cap Range dome, will be appreciably thicker than is recorded in the "Compiled Stratigraphic Section."

There are no shoals known to exist in the Indian Ocean west of the Cape Range to suggest a nearer-basin structure. In the absence of contrary data, it is believed that the Cape Range Anticline is the first structure on the east border of the Indian Ocean basin. The drainage for the Rough Range dome is more restricted, but ample in comparison with that of productive oil structures in other parts of the world.

The Cape Range domed anticline includes approximately 200 square miles within the 1000 feet closing contour; the Rough Range dome includes 20 to 25 square miles within the closing contour. With plus 20,000 stratigraphic feet of marine sediments beneath them, the Indian Ocean floor to the west and the Exmouth gulf to the north and east, the underlying reservoir sands should produce a fluid more valuable than water. In the absence of faulting, and the near symmetry, they approach "Text Book Structures."

ACKNOWLEDGMENT

The author is indebted to Signal Oil and Gas Co. for permission to publish this article and to Dr. N. H. Fisher, Miss Irene Crespin, H. A. Ellis, Government Geologist for Western Australia and to geologists loaned by the Commonwealth Geological Department.

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About the Author

ERIC K. CRAIG was graduated from the University of California in 1914 with a B.S. degree in mining engineering. During the next 11 years he worked in underground and surface operations in Arizona, Columbia, and California. After 13 years as geologist for Shell Oil Company in California and Wyoming, he opened an office in Bakersfield as consulting geologist in 1938. The following eight years were occupied in field exploration in the Rocky Mountain states, West Texas, New Mexico and California, for various companies including General Petroleum Corporation and Richfield Oil Company. He retired in 1946 and re-entered active work for Australian and New Guinea exploration in 1948-49.

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Work Starts on

$90 Million Canadian Pipe Line

By CECIL W. SMITH
Statistical Editor

BENEFITS of important oil discoveries in Alberta will be extended to wider areas of Canada when Interprovincial Pipe Line Company, Ltd., completes its $90 million, 1150-mile pipe line connecting these western fields and the Great Lakes in October, 1950. Scheduled to get under way in March, this line, Canada's first great oil line, will supply Ontario refineries and will overcome part of the transportation problems that have been handicapping growth of the new fields.

At present, transportation costs limit Alberta crude to the prairie provinces of Alberta, Saskatchewan and Manitoba, and production in this region has reached a point exceeding its own requirements, making outside outlets necessary if full development of the prairie resources is to be made. Cost of transporting this crude by rail to Canada's eastern markets is prohibitive, and this line is designed to provide the most economical method of moving it to the Ontario refining centers.

The shortest possible route to the Great Lakes is also the easiest and least expensive, as it follows the prairies. However, in order to take this short route, it will be necessary to lay about 360 miles of line across the border into the U. S. Had an all-Canadian route to the Lakes been chosen, it would have called for an additional 121 miles of line at a cost of $10 million.

A wholly-owned subsidiary of Interprovincial, the Lakehead Pipe Line Company, Inc., will own and operate the U. S. section of the line. From the line's eastern terminus at Superior, Wisc., crude will be pumped to lake tankers for the journey to Ontario. Most of the cargoes will be discharged at Imperial Oil, Ltd.'s, large refinery at Sarnia, but plants at Petrolia and Toronto are also expected to receive some Alberta crude.

Capacity of the new line will be 95,000 barrels a day as far as Regina, but from that point a smaller diameter line will be capable of delivering 70,000 barrels daily to the Wisconsin terminal. At that point, tankers will load crude at an estimated average rate of 57,000 barrels a day. This does not mean the pipe line will deliver 57,000 barrels each day, for navigation on the Lakes is closed about five months out of the year. In winter, the line's delivery rate will be cut to about 10,000 barrels a day.

Storage facilities capable of holding 1½ million barrels will be erected at Superior to hold the reduced winter's runs, but the line will operate at near capacity during the rest of the year.

Until the recent Alberta oil discoveries, Canada had to import about 90 percent of its oil. In 1949, even with limited distribution of the western oil, Canada saved about $90 million that it otherwise would have had to spend for U. S. and South American crudes. It is estimated that

with the pipe line in operation an additional 40 million a year of scarce U. S. dollars will be saved. Even though the prairie fields may eventually prove capable of furnishing all of Canada's needs, it still may be more practicable for some provinces to import rather than transport over the great distance from Alberta. In other words, Interprovincial's and possibly others' in the future will certainly make the country more self-sufficient oil-wise, but imports will continue to be substantial.

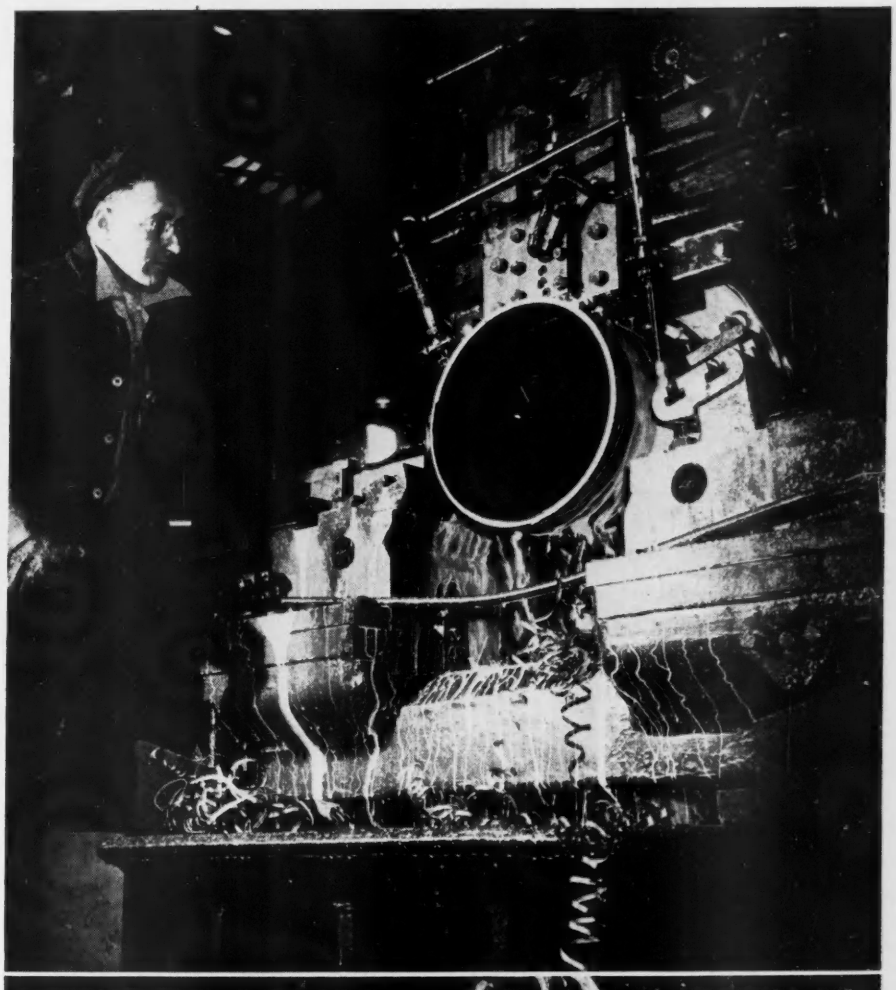
Contracts for laying the line have been awarded and construction is scheduled to start in March. The 450 miles of 20-inch pipe between Edmonton and Regina will be built by Canadian-Bechtel Company and Fred Mannix & Company of Calgary. The spread totaling 340 miles of 16-inch between Regina and Gretna near the U. S. border will be laid by Williams Bros. Corporation, Tulsa, and the U. S. section from Gretna to Superior, Wis., amounting to 360 miles of 18-inch pipe, was awarded to Anderson Bros. Corporation, Houston.

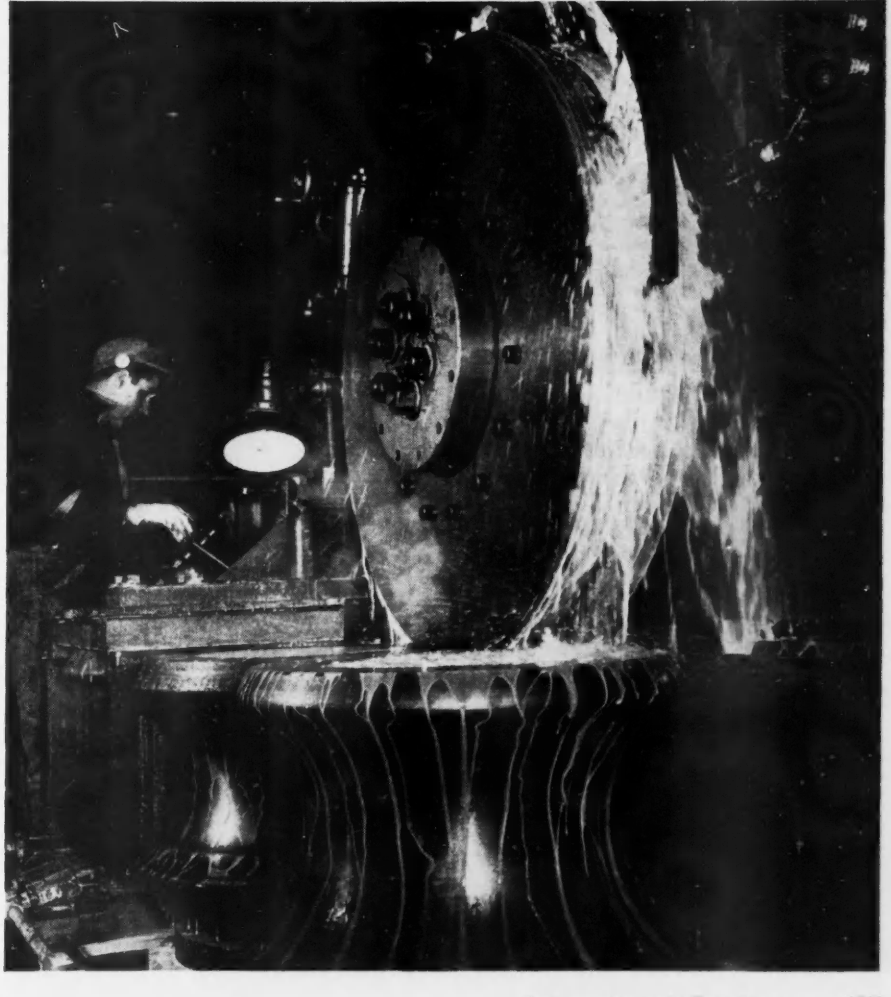
Total cost of the project has been estimated at $90 million, which includes cost of six pumping stations. Two of these will be installed on the Edmonton-Regina leg and four others at Regina, Cromer, Gretna, Canada, and Clearbrook, Minnesota. By doubling the number of pump stations in the future, capacity could be increased by 50 percent.

Imperial Oil, Ltd., parent of the builder, says that to just fill the line before a drop emerges from the discharge end, it will take 1,838,000 barrels of oil. That would be enough to supply all of Canada for six days. Or if the oil were gasoline, it would be enough to drive an automobile 1,158,000,000 miles — 46,300 times around the earth.

Steel pipe weighing 175,000 tons will be required, or enough steel for 1000 miles of main line railway track, or enough to make 2½ ships the size of the Queen Elizabeth. It would even make 118,000 average-sized passenger cars.

Oil will move in the line at a speed of about two miles per hour, taking 26 days for a barrel of oil to negotiate the 1150-mile length.





Top: Production of big pipe needs intricate machines. This one cuts, faces and bevels the ends of the pipe, making it ready for welding in the field.

•

Bottom: This continuous welding machine closes the seam in the 16-inch pipe (lower right) as it rolls under the big copper wheel. Welding is electric, with 3000 amperes used in the process. The white liquid flowing over the wheel is an oil and water cooling mixture.

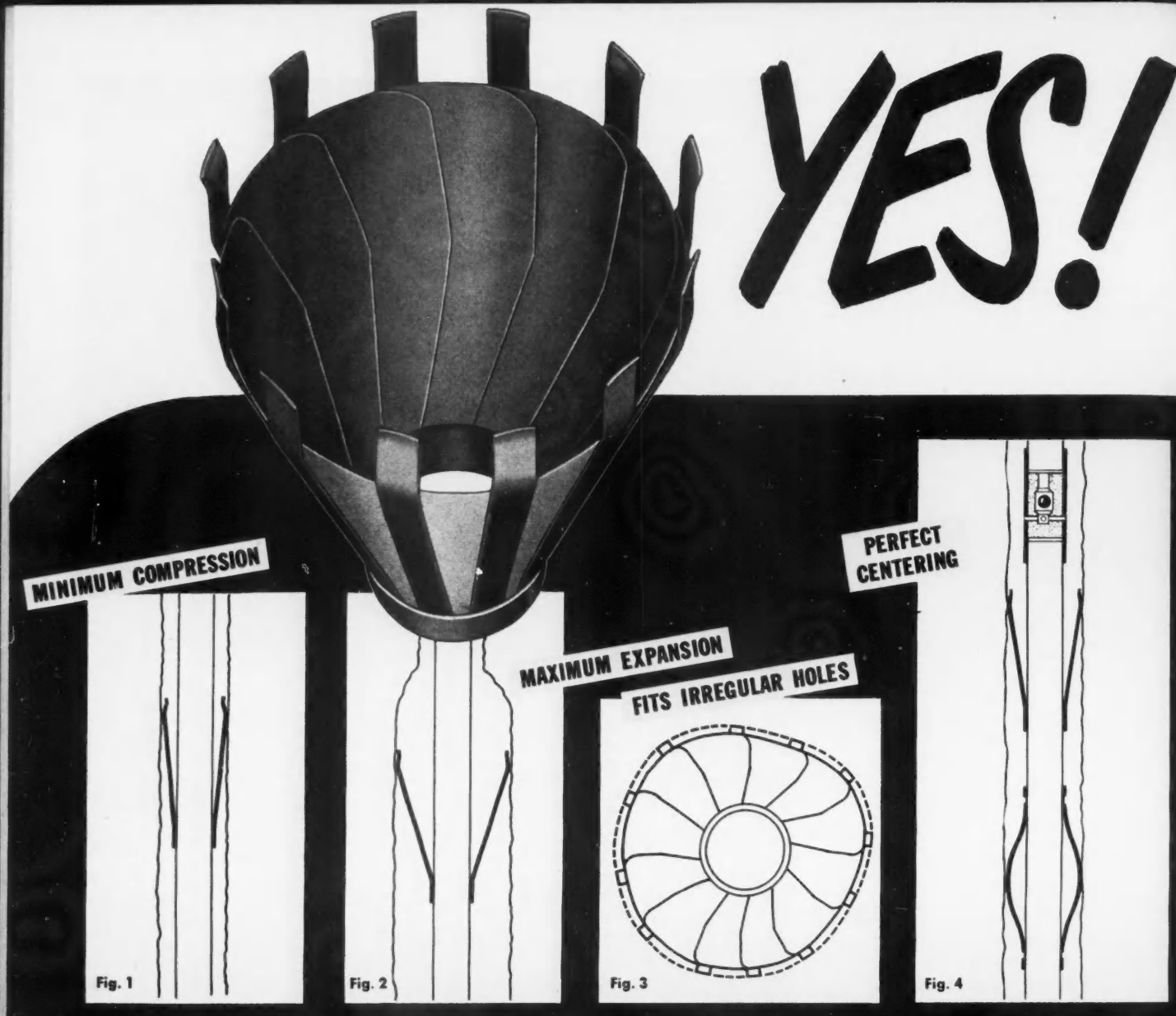


FIG. 1—Running in casing or liner equipped with a Baker Metal Petal Basket. Minimum safe annular clearances are sufficient for safe passage of the basket assembly.

FIG. 2—Basket expanded in hole which has been "bottle-necked" by using a Baker Rotary Wall Scraper. The expansion range of the overlapping "Petals" permits such special cementing.

FIG. 3—The flexible Metal Petal Basket readily expands to contact the entire circumference of holes of irregular shape, and forms a strong, one-way packer which prevents downward movement of the cement slurry.

FIG. 4—Maximum efficiency of the Baker Metal Petal Basket is assured when a Baker Model "G" Casing Centralizer is used to secure a uniform annulus in which the Basket may expand.

FOR any cementing problem where a **lower** zone must be protected from contamination by the cement slurry (as well as from sloughings or cavings) the Baker METAL PETAL Basket will be found both safe and successful.

The unit is constructed of a number of individual "petals" made of flexible sheet metal. These petals are mounted on reinforcing spring steel ribs, which in turn are mounted on a ring to form the Basket. The all-metal construction and design provide ample strength; lessen the possibility of splitting or otherwise damaging the Basket while it is being run in the well; and the metals used are unaffected by the usual acids employed for various purposes.

When running in the hole, the upward pressure of the fluid tends to close the "petals" thus providing fluid passageway between the Basket and the walls of the hole, without distortion of the Basket. As soon as the casing comes to rest, upward pressure by the fluid is relieved and the petals expand to contact the walls of the hole. Any tendency of the fluid to move downward then presses the flexible petals more firmly against the entire circumference of the hole. Solids which are strained from the fluid tend to build a bridge inside the Basket which is thus converted into a one-way packer of great strength and effectiveness.

The "Metal Petals" not only expand to contact the entire circumference of large-diameter holes, but also pack-off in holes of irregular shape; and the independent action of the individually mounted, overlapping petals permits successful use of the Basket in casing programs with minimum clearances.

MOUNTINGS MEET ALL NEEDS

The Baker Metal Petal Basket is furnished as a separate unit for installation in the field on the customer's casing, either as a fixed unit or as a slidable unit (with the use of stop rings). When desired, the Baker Metal Petal Basket can be furnished affixed slidably or stationary on a plain or perforated nipple to meet the requirements of the cementing job to be performed.

For details see the BAKER (or Composite) CATALOG; or ask any Baker representative for specific recommendations on your cementing problems.

METAL PETALS are different!

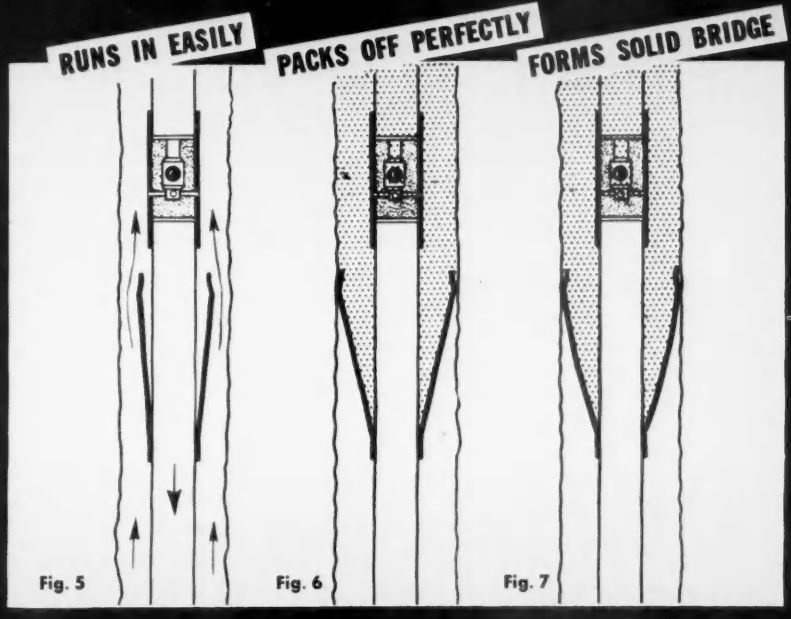


FIG. 5—When running pipe in the hole, the Metal Petals readily compress as the fluid exerts an upward pressure. Normal speed of running-in is maintained, and friction of the Basket assembly against the I.D. of the casing, or of the open hole, is avoided. FIG. 6—When the casing comes to rest, the Basket expands against the walls of the hole. Further downward passage of fluid from above is effectively minimized, until (FIG. 7) the solids strained out of the fluid build up a solid bridge inside the Basket, which then serves as a strong, safe, one-way packer.

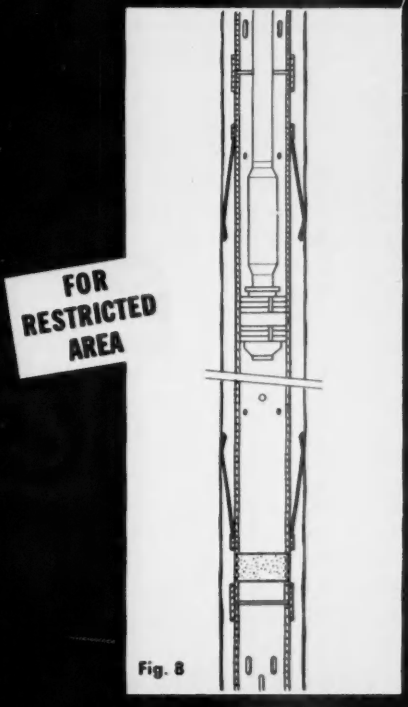


FIG. 8—By using a Baker INVERTED Metal Petal Basket, to provide an "opposed" basket hook-up, it is possible to perform special cementing operations, such as cementing a blank section of pipe, as shown above.

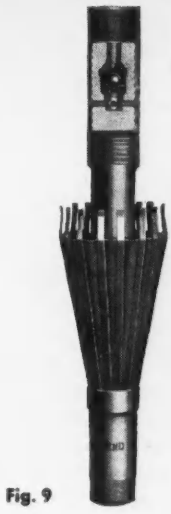


Fig. 9

Fig. 10

FIG. 9—A popular hook-up consists of a Baker Metal Petal Basket, mounted on nipple, with a Baker Cement Whirler Float Collar with Solid Baffle (Product No. 305) which causes the cement slurry to pass through the baffled, side-whirler ports.

FIG. 10—When the casing is to be rotated or reciprocated while cementing, the Metal Petal Basket is "slidably" mounted between two Stop Rings. This permits free rotation and ample vertical movement of the casing without distorting or damaging the Basket.

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PRODUCT NO. 340
BAKER OIL TOOLS, INC.
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Britain Fails to Appease U. S. With

Dollar Oil Compromise

By HENRY OZANNE
Eastern District Editor

AMERICAN oil companies producing and marketing abroad find scant encouragement in the British government's recent proposal to soften its policy of displacing dollar oil by sterling oil throughout the whole sterling area. In fact, the consensus of government and industry experts who examined the British suggestion is that "it fails to offer definite hope for an operating agreement and threatens to squeeze American petroleum companies out of world markets."

Britain proposed to the U. S. State Department a modification of its earlier edict aimed at excluding all dollar-oil imports into the United Kingdom wherever sterling oil was available for substitution. The modification was that Britain would limit to 4 million tons a year the amount of American refined products that would be displaced by British oil. The British offer specified the following maximum figures for substitution in 1950:

Motor spirit	750,000 tons
Kerosine	150,000 tons
Gas/Diesel oil	500,000 tons
Fuel oil	2,400,000 tons
Total	3,800,000 tons

This concession came from London after a storm of protest had greeted the original British order virtually to eliminate all dollar-oil shipments into the sterling area. Secretary of State Acheson denounced the first British decision, and Senator Tom Connally of Texas, chairman of the Senate Foreign Relations Committee, called it "an act of hostility." Britain's edict banning American oil was announced right at the time that American and British conferences were in progress seeking some solution of the whole question. Standard Oil Company (N. J.) in a memorandum to members of Congress showed that the British ban would in effect "liquidate the foreign business of American oil companies in a relatively short period of time." Under pressure of such objection from the U. S. government, the British officials replied with the "compromise" plan which many industry analysts say is inadequate to preserve American oil operations abroad.

Ten American oil companies sent representatives to a meeting with State Department and other government officials in Washington in an attempt to analyze the new British "compromise" program. The companies participating were Socony-Vacuum Oil Company, Standard Oil (N. J.), Gulf Oil Corporation, The Atlantic Refining Company, American Independent Oil Company, Standard-Vacuum Oil Company, Arabian American Oil Company, Standard Oil Company of California, Cal-Tex, and The Texas Company. All conferees were agreed that the British "compromise" left crucial problems untouched and in general still indicated that Britain intended—by more polite means—to grab the world's oil markets.

Talks Unsatisfactory

Following the session with the State Department, the American companies turned directly to British officials in an effort to clarify British petroleum policy. Company representatives met with Sir Leslie Rowan and Victor Butler of the British Ministry of Fuel and Power, and these conversations also proved inconclusive as to the fate of American foreign operations, according to a number of industry spokesmen. American oil men are discouraged by the fact that in several sterling area countries dollar-oil restrictions are being enforced by a licensing system as well as by currency controls. In other countries, such as Argentina, Sweden, Egypt, bilateral trade agreements prevent American companies from selling for sterling even if the currency is used entirely for purchase of goods and supplies in the United Kingdom. Ernest O. Thompson, Texas Railroad Commissioner, has described such tactics by Britain as an attempt to "fence out American oil" while the British take over the international trade.

Furthermore, while the British action is purportedly dictated by a desire to save dollars in the purchase of British petroleum requirements, actually Britain can find its restrictions resulting in a larger dollar cost than previously. So-called sterling oil, produced in Venezuela, has a higher dollar cost than does "dollar oil" produced in the Middle East.

In fact, the British have refused to "dollar oil" produced in the Middle East. oil or dollar oil. "Sterling oil" does not necessarily mean British oil by origin, ownership or destination; it means merely what the British government decides to admit into the United Kingdom.

Walter J. Levy, petroleum consultant, and formerly chief of the Economic Cooperation Administration's petroleum division, told the American Institute of Mining and Metallurgical Engineers in New York that the whole future of American-owned foreign oil concessions is threatened by the dollar shortage. He said:

> "American oil production worldwide requires dollar expenditures for dollar equipment and dollar services. The production of oil by British companies also costs a sizeable amount of dollars, but while the British companies, operating with strict currency controls, must deliver to the British Treasury all their foreign exchange income for pound sterling, they are also entitled to convert sterling into dollars for their necessary expenditures. British companies, therefore, can sell their oil for sterling or for the local currency of their customers. Since sterling is more plentiful in world trade, sterling oil is generally favored. With rapidly increasing production sterling oil will tend more and more to take over traditional dollar-oil markets.
>
> "Any resulting large decline of American-owned production is bound to have serious effects on the stability of American-held concessions and on the general economic conditions of the countries where American oil companies operate.
>
> "The British government may have overlooked the fact that the world oil industry is not a British industry whose production, distribution and prices are subject to Britain's effective control. Any undue government interference in one segment of the

INSIDE INFORMATION

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world oil economy might have unpredictable consequences in another. If, as a result of unilateral actions by the British government, American companies should be faced with a prolonged and severe loss of production or with unmanageable sulpluses, they might have to reduce their prices in order to maintain a high level of sales.

"When prices for American-owned foreign oil declines, British oil prices are likely to follow for two reasons: first, any dual price system for foreign oil—a higher price in sterling and a lower one in dollars—would in fact imply a further devaluation of sterling through oil; and second, if the price spread between dollar and sterling oil should become large, many of the consuming countries might prefer cheaper dollar oil to more expensive sterling oil, so that ultimately the price of sterling oil would come down. Obviously, such extreme developments would result in an extraordinary loss of income to the British oil companies (as well as to the American companies) and would seriously hurt the British economy."

Levy pointed out that from a strictly dollar point of view, the dollar cost to Britain of American-owned Middle East oil shipped into the sterling area is less than that of British-owned Venezuela oil.

Meanwhile, ECA has announced a $7,588,000 decrease in the amount of financing for installation of an oil refinery in Britain. The project for Shell Haven refinery, near London, was originally planned to cost the equivalent of $58,400,000, including $10,043,000 in ECA funds. ECA has cut its contribution to $2,455,000 and the project's cost has been reduced to $34 million. Distillation capacity of the plant has been reduced from 66,000 to 40,000 barrels a day.

Japan Purchasing Heavily From Sterling Sources

Japan is currently purchasing from sterling sources more than 1 million barrels of crude, with delivery scheduled for the last quarter of this year, it has been disclosed. Many industry observers fear that American oil interests will soon be squeezed completely out of the Japanese market as Britain follows her present trade policy of enlarging the sterling bloc by bilateral trade agreements.

A new Japanese-British trade pact was signed in September with the approval of occupation authorities. Since that time all oil bid deals have been subject to sterling exchange control. The only dollar oil allowed in Japan recently was a shipment of 660,000 barrels from American firms using U. S. appropriated funds.

Japan's import trade reverted to private basis January 1, 1950, but effective British controls over currency are hitting American companies, many of which would be willing to sell in Japan for sterling, but are barred from even that kind of business. Some of the barred American subsidiaries are registered British firms. Britain notified the Supreme Commander of the Allied Powers that American oil companies will be allowed to participate in Japanese petroleum trade only under the following conditions:

1. The American companies must supply all oil from sterling sources.
2. They must use sterling proceeds to purchase Japanese produce.
3. They must ship such produce to sterling areas.
4. For that final sale of the produce in the sterling area, the companies accept non-convertible sterling.

These conditions are more stringent than those which Britain imposes on British companies which are permitted to sell oil from any source, to remit proceeds direct to London without intermediate produce purchases, and receive large dollar exchange in conversion.

Four refineries now operating in Japan are supplying practically all of the island's oil requirements. These refineries were able to step up runs to near maximum capacity early this year with the arrival of $10 million worth of sterling crude.

The million barrels of crude which will be delivered in Japan about September will come chiefly from British Middle East fields.

Central Queensland Wildcat May Be Spudded in March

Preparations are about complete for a deep wildcat in Central Queensland, Australia. As a result of extensive core drilling completed in 1949, Shell (Queensland) Development Proprietary, Ltd., a member of the Shell Group, is moving in equipment and preparing to rig up its Morella No. 1, 40 miles south of Rolleston.

Heavy drilling equipment was shipped from England to the port of Brisbane and transported 700 miles overland to Rockhampton. The derrick and most of the heavy rig units have been hauled another 200 miles west to the well site and erected. Drilling may get under way during March.

About 30 core holes were drilled to an average depth of 800 feet in this region during 1948 and 1949, and it was on the basis of this structural drilling that the wildcat was located. A portable drilling unit was employed in this exploration along with a truck-mounted electric logging unit for well correlation.

The heavy-duty rig to be used is British-built with a 136-foot derrick and capable of drilling to 12,000 feet. This depth was selected in order to penetrate all possible oil horizons, and is expected to be reached by the end of 1950. To accommodate 60 to 70 crew members, a camp and recreational facilities were completed in January.

Burmah Oil Schedules Test In Upper Assam Jungles

An oil test in the jungles of Upper Assam, India, is planned at Barsilla, where Burmah Oil Company, Ltd., will drill in a fold of rocks above the Naga thrust. Decision to drill at Barsilla was made soon after cessation of operations at Tiru Hills, Assam, where an unsuccessful test was completed late in 1949.

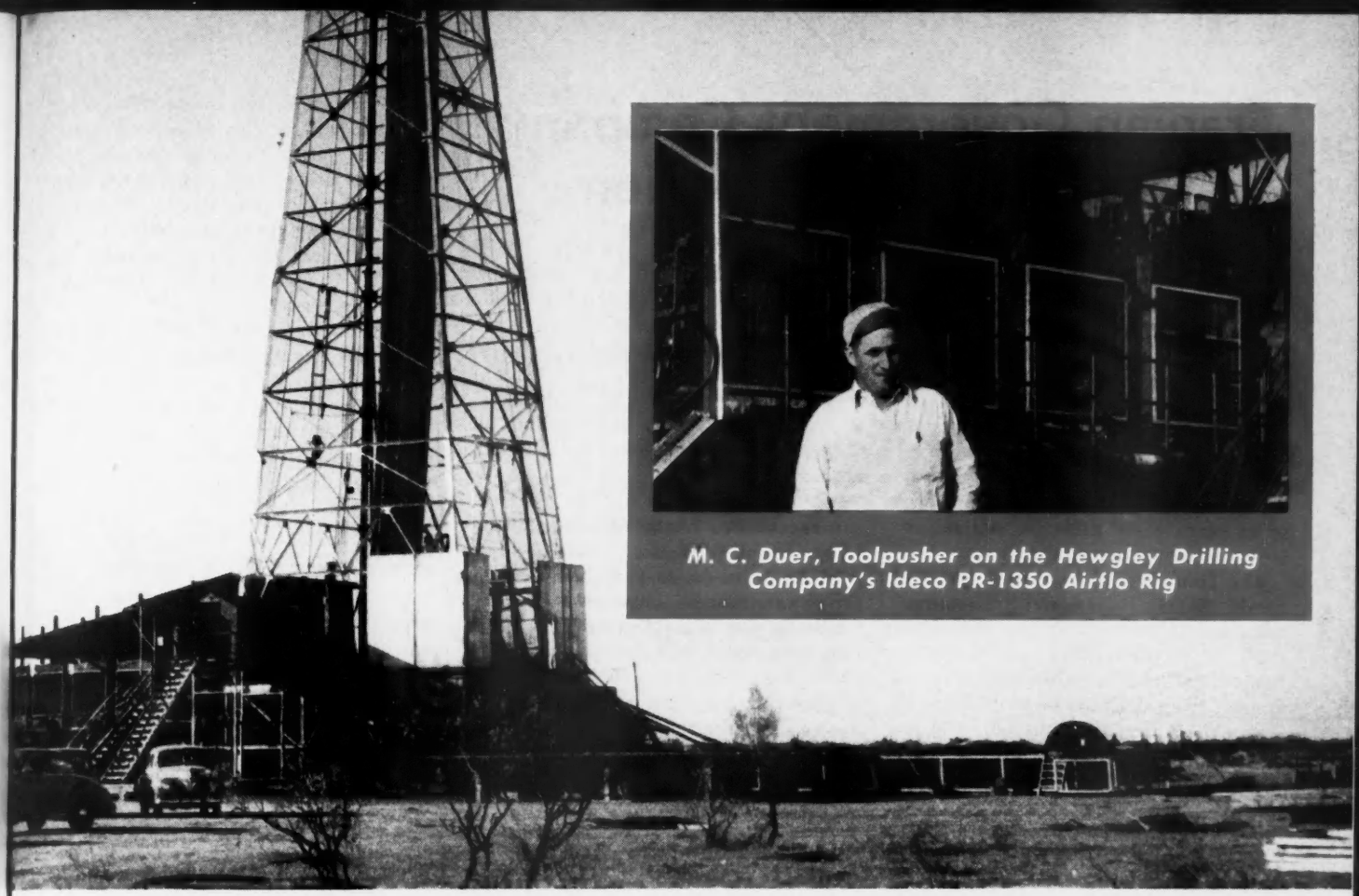
The rotary rig used at Tiru Hills was moved to the Barsilla location, and BOC's Indian Concessions subsidiary of Digboi is drilling the well.

A combination of interacting circumstances has prevented the Burmah Oil Group from again placing in operation the refinery at Syriam. The plant was destroyed in "denial" operations during the war, and attempts to reconstruct it have been held up by the civil insurrection and other factors. Progress in reconstructing the Yenangyaung oil field in central Burma, and the main Burma pipe line which runs through insurgent territory from the oil fields to Syriam, has also been delayed. Without the pipe line no full scale operation of the country's oil industry is possible; there is no way to send crude from the oil field to Syriam, and this in turn is delaying reconstruction of the plant at that seaboard refining center.

A small volume of crude is being produced in Burma and converted at the Chauk topping plant into a limited range of petroleum products for the local market. When communications and transportation lines to outside markets are reestablished, crude oil production and refining will be increased.

USSR Concentrates Operations In Matzen Area of Austria

Reports from Europe indicate that the Soviets are concentrating much of their attention in Eastern Austria on the new Matzen area opened just after the beginning of 1949. The latest completed well flowed in excess of 5000 barrels daily, contrasted with average production of about 700 barrels daily from early wells.



M. C. Duer, Toolpusher on the Hewgley Drilling Company's Ideco PR-1350 Airflo Rig

HEWGLEY DRILLING *Sets* NEW RECORD *with* IDECO PR-1350 Airflo RIG

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Closely following the performance on the Elliott A-2, the Elliott C-2 was drilled to 10,000 feet in 33.74 days. The drilling time reported on these two wells proves conclusively the uniform efficiency and matchless engineering of the Ideco PR-1350 Airflo Rigs.

How do they stand up after breaking a record? Mr. J. M. Hewgley, Jr., says, "Both our rigs are in excellent mechanical condition."

The PR-1350 is recommended for drilling to depths of 15,000 feet with 4½" drill pipe when powered with engines developing 1350 H.P. It has nine hoisting speeds, nine rotary speeds and one reverse speed, which gives it a flexibility never before attained in mechanical rigs.

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Iranian Government Company Would Bar Competition

IRAN plans to establish a government oil company in a new national project which may end hopes of American companies to participate in the development of this petroleum-rich land.

The plan for the new Iranian government company has been blue-printed by a group of American engineering firms associated as Overseas Consultants, Inc. The oil project is part of a seven-year, $750 million program to modernize and industrialize Iran.

The Iranian government oil company would be an independently financed undertaking, paying costs out of cash on hand, and presumably would derive funds from the oil royalties of the Anglo-Iranian Oil Company, now operating in Iran. Anglo-Iranian is the only foreign concern operating in Iran's oil fields, and its concession would not be affected by the new government venture.

The Iranian company would be a joint stock company with a board of seven directors, of which three would be technical experts. One provision of the plan is that one of the board members would be a skilled American driller, and production drilling would be done on a contract basis, preferably with American operators. The first year's cost of the project is limited to $250,000, but about $10 million would be spent over the course of the seven-year program.

The Iranian government already has eight regions marked as oil-favorable areas in which first operations of the new company would begin. These are as follows:

1. A strip of 110,000 square kilometers bordering the Caspian Sea and the Soviet border.
2. A 120,000 square kilometer area of north central Iran, south of the Elborz, where some survey work has already been carried out.
3. The 56,000 square kilometer coastal area of Makran, which in effect is an extension of Anglo-Iranian's concession area.
4. A 75,000 square kilometer belt bordering the A-I concession proper.
5. A 110,000 square kilometer area west from the Pakistan border.
6. A 120,000 square kilometer area west from the Afghanistan border.
7. The province of Azerbaijan.
8. Offshore areas in the Gulf of Oman and in the Persian Gulf.

American interests have long shown a desire to enter Iran's oil fields, but no successful contracts have ever been drawn. Iran granted its first concession in 1872 to a British operator, and the country's first well was drilled in 1884. The basis of the modern oil industry in Iran, however, dates from the 1901 concession contract won by an Englishman, William Knox D'Arcy and covering all the country except the five northern provinces.

Oil was discovered in Iran in 1904, and the famous Masjid-i-Suleiman field was opened in 1908.

In 1909 the Anglo-Persian Oil Company was formed (later renamed the Anglo-Iranian Oil Company), and in 1914 the British Admiralty invested about $10 million in this concern, acquiring thereby a majority interest. At the present time the British government owns about 52 percent of the voting stock of A-I.

In 1933 the D'Arcy contract was canceled in a dispute with the government and a new contract was awarded for 60 years, but A-I's exclusive rights were thereby abolished.

American interests made their first bid to enter Iran in 1920 when the government announced it would grant an oil concession in the five northern provinces to "Standard Oil or other independent and reliable American oil companies." This contract was to run for 50 years, and called for a 10 percent royalty. However, the deal met popular opposition and was dropped.

In 1922 a new proposal was made for a 40-to-50 year concession and negotiations were opened with the Sinclair interests, but these talks ended without agreement.

Iran began talks with Russia in 1929 for a joint Soviet-Iranian company, but this proposal lapsed without action.

Another American company became interested in Iran in 1937 and Iran proposed a new law granting a concession to the Amiranian Oil Company of Delaware, a Seaboard subsidiary, in the north and northwestern part of the country. This law was ratified and the concession was awarded for 60 years. During 1937-1938 survey work was carried on by Amiranian, but the company then surrendered its concession before drilling. Withdrawal of the American operator was caused by the discovery of oil in Saudi Arabia and other parts of the world more favorably situated for transportation.

Other American interests opened negotiations with Iran in 1944, particularly for a concession in Baluchistan, and these conferences ran into conflict with others then being carried on by Russia. So bitter did the Iran oil dispute become that a law was passed forbidding any Iranian government official to discuss petroleum problems with a foreigner. This law swept away hopes of both the Russians and the Americans for oil concessions.

While the law, admittedly unrealistic, still stands, the proposed government oil company is seen as a means of preserving Iranian national interests over petroleum and at the same time obtaining the skills of American experts in further oil development.

Kuwait-Saudi Arabia Area Structural Test Completed

The first structural test has been completed in the joint program of American Independent Oil Company and Pacific Western Oil Corporation for the determination of the structural features of the Kuwait-Saudi Arabian Neutral Zone.

About 16 miles south of the Kuwait border, the well was carried deep enough to obtain electric log correlations with the Burghan oil field wells 20 to 25 miles to the north. These indicated that the No. 1 test was probably on the east flank of a structure running north and south.

The rig was moved to a new location west of the first test, and another well was scheduled to be started immediately.

Chile's First Export Crude Sent to Uruguay Refinery

Chile joined the ranks of oil exporting countries with its first shipment of crude to the Administración Nacional Combustible Alcohol y Portland (ANCAP) refinery in Uruguay. A contract has been made between ANCAP and Corporación de Fomento de la Producción (CORFO), the Chilean operating company, for continued shipments during the next 18 months.

Production in Chile, all from the Magellan area, is now 2000 barrels daily, and as more wells are brought in is expected to reach 10,000 barrels per day, a level adequate for domestic consumption. Plans are being studied for construction in the Valparaiso area of a refinery which would go on stream in 1952.

Imperial Awards Contract For Refinery in Winnipeg

Canadian Kellogg, Ltd., has been awarded a contract by Imperial Oil, Ltd., for engineering and constructing a refinery in Winnipeg, Manitoba. The refinery will have a capacity of 12,000 barrels per day and is scheduled for completion by May, 1951.

Deep Discoveries Increase

Mexico's Oil Reserves

By JORGE L. CUMMING
Director of Exploration, Petroleos Mexicanos

DISCOVERY OF DEEP PAYS and extensions in producing fields, notably Poza Rica, have bolstered Mexico's proven reserves considerably in the last decade. Estimated in 1939 at 600 million barrels, the reserves are now figured by the author at 1 to 10 billion. This article is from an address, "Oil, Its Origin, Geology and Exploration Methods — National and World Reserves," presented before the Geographical and Statistical Society of Mexico.

THE Mexican economy is closely related to the Mexican oil industry since at present the oil industry is the principal supplier of energy. According to data calculated by the Department of National Economy, 85 percent of the energy used by the other national industries is provided by oil and its by-products. The remaining 15 percent is furnished by the use of coal and hydroelectric plants. Besides the energy acquired from oil and its by-products, a large quantity of these by-products are used in the form of lubricants and also many of them serve to give light and heat to a large percentage of the Mexican population.

The industrial progress of the country requires, as time goes on, greater volumes of oil products to satisfy the demand of Mexico's expanding systems of transportation, mechanized agriculture, and new industrial centers which, from the economical point of view, are located far from the coal producing areas and hydroelectric power plants.

This gives an idea as to the importance to Mexico of having proven oil reserves in sufficient quantities to take care of these anticipated needs, aside from the benefits accruing to the general economy of the country, represented by the export of surplus crude so as to strike a more favorable trade balance.

The Mexican oil reserves can be divided into two groups: First, those reserves which can be estimated as obtainable, because they have already been found and are being produced; and second, those reserves that, from the geological standpoint, are considered to be potential reserves and can be discovered by advance methods of exploration, after having taken into consideration the general possibilities of those regions considered to be petroliferous.

In regard to the reserves already proven, they can be defined as those comprising certain volumes of oil in place in the reservoirs already discovered and which can be economically produced by conventional production methods.

The methods employed to calculate the proven reserves are based on a direct approach. The volumetric capacity of the porous media occupied by the oil is calculated, and from this capacity is deducted a percentage of oil not recoverable because of lack of pressure within the reservoir or because of adhesion of the fluid to the porous media which contains it. By an indirect approach the proven reserves can be ascertained through the use of the production decline curves for the wells which deplete the reservoir.

Prior to March, 1938, information pertaining to the oil reserves of the Mexican oil fields under exploitation was difficult to obtain due to lack of data made available by the companies then operating in the country.

Upward Trend

After 1938, Petroleos Mexicanos started an investigation of this important problem and by 1939 the approximate calculations showed that Mexican oil reserves were about 600 million barrels.

The first detailed work for the calculation of the oil reserves was started by Manuel Rodriguez Aguilar in 1941, and from this study the following results were obtained:

Field or Zone	Reserve Million of Barrels
Poza Rica	597
Tampico-Tuxpan	153
Zona Sur	71
Total	821

By the middle of 1947 the calculations showed the following figures:

Poza Rica	932
Tampico-Tuxpan	90
Zona Sur	36
Total	1058

This increase in proven reserves is due to the discovery of deeper producing horizons and to the increase added by the extensions carried out in producing fields, principally at Poza Rica.

Since the beginning of 1948 it can be stated emphatically that Petroleos Mexicanos has started an upward trend in the discovery of proven reserves. The added proven reserves plus the discovery of new oil fields and the extensions carried out in the fields under actual production have augmented the value of the reserves. According to up-to-date calculations the reserves amount to 1 to 3 billion barrels, not counting the condensate fluids which accompanies the natural gas associated with the oil and the condensate from the wells producing natural gas only.

The areas where these discoveries have taken place are as follows: During the last two years along the frontiers of the State of Tamaulipas, the Reynosa and Francisco Cano fields were discovered. These fields also have sands which produce sand only. In this same region, the fields of Mision, Camargo, Valadeces, and Brasil, which are natural gas producers with small percentages of distillate and liquefied gas, were also found.

West of Tampico, in the zones of Ebano-Panuco and Cacalilao, oil is found in fractured zones embracing the compact limestones of the San Felipe and Tamaulipas formations. These fractured zones are difficult to detect by surface methods of exploration, but nevertheless, encouraging results have been obtained lately by the discovery of new fractured zones in the region of Limon, located south of Ebano.

Through field geological studies and research, the field of Moralillo was discovered. Moralillo is a short distance

west of the oil field of Cerro Azul. This new discovery is being actively explored and exploited and has increased the over-all daily production and reserves.

In the Golden Lane, which extends from the shore of the Tamiahua Lagoon to the Tuxpan River, new producing zones have been found through detailed subsurface geology studies. These zones of the Golden Lane offer good prospects from the standpoint of new reserves.

The Poza Rica area has contributed more than any other to the increase of proven Mexican oil reserves. In March, 1938, Poza Rica had 20 producing wells and today it has 90. These additional wells have permitted the increase of knowledge of the region and the extension of the field has added to proven reserves.

In August, 1949, near the city of Papantla and southeast of Poza Rica, a new oil field was found. This field, named President Aleman, has stratigraphic conditions very similar to those of Poza Rica. Importance of this discovery will be known soon. Drilling development work that will outline the aereal extent of the structure is proceeding in an accelerated manner.

Leaving the Veracruz oil fields region, the most important discovery during recent months is that of the Fortuna Nacional, in the Municipality of Macuspana, State of Tabasco. This field was first drilled by El Aguila Oil Company, but the wells were shallow and no commercial production found. In 1949 Petroleos Mexicanos drilled a deep well and Miocene sands were found. This first well, which is also the first producer in the state, made an initial production of 300 barrels per day of light gravity oil. The first attempts to find oil in Tabasco were carried out in 1901. Besides this discovery, sands containing gas under high pressure were discovered in the Sarlat field.

The Mexican oil industry has traveled far during the last 11 years. Prospects for 1950 promise a production in excess of 70 million barrels. This production will take care of Mexico's increasing domestic demand and will permit the export of a certain percentage of Mexican crude.

Potential reserves may be said to comprise large areas which present favorable regional conditions for the existence of commercial oil reservoirs. This acreage covers a great part of the Mexican Gulf Coast and the coastal plains.

Conservatively estimated reserves to be discovered represent, at least, a figure greater than twice all the crude produced and discovered up to date, or, approximately, 7 billion barrels.

Pemex Plans Barter Pacts

Mexico's state oil monopoly, Petroleos Mexicanos (Pemex), is planning to enter into barter agreements with a number of European countries through which Mexico's oil will be traded for foodstuffs, machinery and construction equipment. Pemex hopes it may dispose of as much as 20 million barrels of crude this year through such arrangements. Such an export volume would be nearly 50 percent over the 1949 level.

Antonio J. Bermudez, Pemex director, predicts Mexico's crude production will reach 75 million barrels in 1950 compared with 62 million produced last year. This hope for increase is based in part on the new discovery near the El Plan zone in southern Vera Cruz state. Pemex is doing the drilling here unaided by outside contractors. The work resulted in a discovery shortly after the first of this year when oil sands were penetrated at about 4000 feet. No reports have yet been issued on the well, which if it proves productive will open a new producing area where ten previously drilled wells failed to find oil.

Mexico has been stepping up crude output for 12 consecutive months. A new high was reached at the close of 1949 when production topped 193,000 barrels a day as against 172,713 in November and 171,344 in December last year. Pemex expects daily production to reach 250,000 barrels daily by the close of 1950.

At the same time crude exports have been rising. December shipments totaled 1,566,400 barrels compared with 1,266,000 barrels for the preceding month and 1,364,000 for October.

Mexico plans to obtain much of her oil field producing equipment from barter agreements with the European nations. Large orders of equipment and supplies are needed, Bermudez said, for expansion and renovation of refineries and construction of pipe lines. The barter program is viewed as Mexico's answer to the inability of Pemex to obtain a $300 million loan from the U. S. for petroleum development. Bermudez hinted that barter negotiations are now being conducted by Mexico with France and Western Germany. It is not known whether Britain may also be involved, although London has concluded several such trade pacts, notably with Argentina, Sweden and Egypt.

Creole's Refinery Nearing Completion at Amuay Bay

Creole's new refinery of 60,000 barrels a day rated capacity is nearing completion at Amuay Bay, on the western shore of the Paraguana Peninsula in Western Venezuela. After about three years of construction, the first unit, an atmospheric pipestill, went on stream January 3, final completion of all equipment scheduled next fall.

Creole's decision to build a new refinery in Venezuela grew out of the 1943 petroleum laws, which require each producing company to refine within the country a minimum percentage of the oil produced. As a consequence, there are several new refineries building in Venezuela and Creole's Amuay unit is the second to be put into operation, Shell having begun operations at its Punta Cardon refinery early this year.

The refinery units include atmospheric and vacuum pipestills, treating equipment and asphalt cutback and oxidizing facilities as well as a steam and power plant, cooling water system and tankage. Finished products include motor gasoline, kerosine, diesel oils, asphalts and fuel oils. The refinery is the deep water terminus of the Amuay-Ule pipe line which handles daily 300,000 barrels of Creole's Lake Maracaibo crudes. In addition, large quantities of crude are brought in by lake tankers for transshipping in ocean vessels to refineries in other parts of the world.

To accommodate the large volume of shipping which enters the port daily, the natural harbor of Amuay Bay has been improved by dredging to a 35-foot depth a large area adjacent to the docks. These latter consist of several piers sufficient to berth six tankers and two cargo ships simultaneously.

A complete town has been built alongside the refinery site to house a portion of the families of the 1700 employes required to operate the refinery and terminal. Fresh water will be transported to Amuay by a 70-mile pipe line from the mountains on the mainland south of the City of Coro.

In addition to the new refinery at Amuay, Creole operates a large refinery of 55,000 barrels a day capacity in Eastern Venezuela at Caripito and formerly operated a smaller one at La Salina on Lake Maracaibo. The latter has been shut down recently and the major portion of the operating crew transferred to Amuay.

Middle East Output Nears 1.5 Million Barrels Daily

MIDDLE East production is approaching 1.5 million barrels a day with increased output recorded in all the chief producing areas except Bahrein, according to preliminary figures compiled by J. Terry Duce, vice president of Arabian American Oil Company, and presented to the American Institute of Mining and Metallurgical Engineers in New York. Duce's figures for 1949 crude output, compared with official figures for 1948 follows:

	(in thousands of barrels) 1948	1949	Percent Increase
Iran	190,395	204,000	7
Saudi Arabia	142,850	174,000	19
Bahrein	10,900	10,000	—1
Kuwait	46,500	90,000	94
Iraq	26,400	28,000	7

American Independent Oil Company has announced that it has completed its first structural test well in the Kuwait-Saudi Arabia Neutral Zone where it is operating in conjunction with Pacific Western Oil Corporation. The first Aminco test was located 16 miles south of the Kuwait border and was carried deep enough to obtain electric log correlations with the vast Burghan oil field wells, 25 miles to the north. The No. 1 test was probably located on the east flank of a structure running north and south, the company reports. The rig has been moved to a new location west of the first test.

During 1950 a total of 96 wells were drilled in the Middle East including: Iran, 4; Saudi Arabia, 24; Iraq, 9; Kuwait, 50; Bahrein, 2; and Qatar, 7. Total number of wells drilled in the Middle East up to the first of this year is 711.

One of the most promising new areas is in south Iraq, where the Iraq Petroleum Company has drilled its third well for what appears to be a major field discovery. In all, 12 discoveries were reported in the Middle East for 1949.

Political uncertainties give a problematical outlook to the Middle East for the rest of this year. Both Iraq and Iran are seeking to increase royalty rates, and drilling costs are expected to rise generally. Iraq is depending on higher oil revenues to finance its country-wide rehabilitation program. Iraq is looking to more pipe line installations that will result by 1960 in a total of 500,000 barrels of oil daily crossing Iraq territory en route to the Eastern Mediterranean. Baghdad also is pushing tighter contracts with the Iraq Petroleum Company by which the company would be obliged to bring the Mosul and Basra fields into production within two years, and to increase the Kirkuk field output by 50 percent.

The south leg of the IPC pipe line from Kirkuk to Haifa, Palestine, is still closed, thus limiting production at Kirkuk to about 40,000 barrels a day. However, Iraq is deriving an annual revenue of about $8,400,000 in fees from the present pumping rate through the old 12-inch line and the newly opened 16-inch line from Kirkuk to Tripoli.

A survey has been completed in many details for a route for another IPC pipe line from Kirkuk to Banyas on the Syrian coast, although construction work will not begin before 1952. The presently planned capacity of this line will be only slightly less than all the four existing lines.

The British Anglo-Iranian Oil Company is still waiting on action by the Iranian government to determine what new royalty rate will be accepted in Iran. A bitter political battle in Iran at the present time between the king and the "thousand families" may defer any oil legislation for months.

Meanwhile Trans-Arabian Pipe Line Company is proceeding rapidly with construction of the 30-31-inch line from the Saudi Arabian fields to Sidon, Lebanon. Pipe is being strung about 500 miles west of Abqaiq, Saudi Arabia, and work has begun at the Sidon end. A bookkeeping entry has reduced the length of this huge trans-desert carrier from 1067 to 752 miles. No construction changes are involved, and the "shortening" merely takes account of the fact that about 300 miles of the line, properly considered gathering line for the Arabian American Oil Company, has been transferred from Tapline to Aramco books.

All-Egyptian Firm to Begin Early Drilling Operations

A new all-Egyptian concern is to commence operations as soon as drilling and other equipment has been assembled, according to Cairo reports. Forecasts are that it will get into active exploration within six months.

The firm, National Petroleum Company of Egypt, was formed last March with nominal capital of $78,640, now being raised to $2,780,000, with plans for further increases as needed. Concessions have been secured on more than 267,000 acres of land in what is believed to be favorable regions on both sides of the Gulf of Suez, on the Sinai Peninsula, the Fayoum area south of Cairo, and at Sollum near the northwest frontier of Egypt and Cyrenaica. According to Torcom Papazian, managing director of the company, production developed will be refined in the government-owned plant at Suez, with any excess over the capacity of the refinery being exported.

Preliminary geological surveys have been made on part of the concession, and company officials were preparing to travel to Europe and the U. S. to select drilling equipment amounting to as much as $4 million to $5 million in value.

Houston Nomads Officers for the 1950 term are, left to right, regent, C. B. McDonald, A-1 Bit and Tool Company; sergeant-at-arms, Lawrence J. Kelley, Hillman-Kelley; vice president, Wayne Rives, *Oil and Gas Journal;* president, Edmond L. Lorehn, Cameron Iron Works; deputy sergeant-at-arms, C. F. (Bud) Vincent, Byron Jackson Company; assistant secretary-treasurer, E. F. (Salty) Baldwin, Hughes Tool Company; regent, E. M. Fontaine, National Tank Company; secretary-treasurer, Tracey T. Word, Jr., Well Equipment Manufacturing Company; and executive secretary, H. E. Estes, A-1 Bit and Tool Company.

18
DRILLING SWIVEL MANUFACTURERS HAVE THEIR CATALOGS FILED IN COMPOSITE CATALOG

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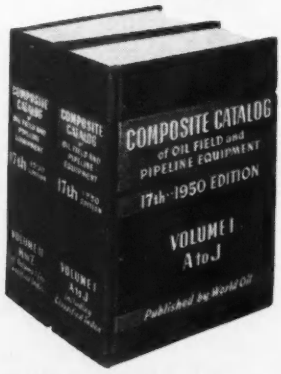


THE UNIVERSAL EQUIPMENT GUIDE FOR OIL COUNTRY BUYERS

COMPOSITE CATALOG

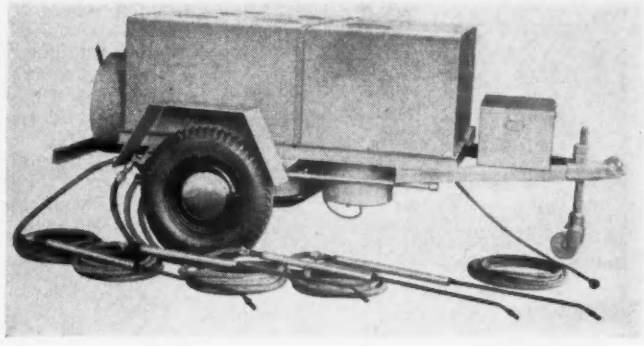
DESCRIPTIONS OF NEW EQUIPMENT IN THIS ISSUE OF WORLD OIL ARE SUPPLEMENTS TO THE MANUFACTURERS' PRE-FILED CATALOGS IN COMPOSITE CATALOG

NEW AND IMPROVED EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

95—High Pressure Steam Cleaner

This item supplements Homestead Valve Manufacturing Company data as shown on page 2296 of the Composite Catalog, 17th Edition.



A new steam cleaner is adapted to do large cleaning jobs and also for heat-transfer uses. Known as the Hypressure Jenny steam cleaner, it has 300 gallons per hour capacity and will operate from one to four cleaning guns. Full operating pressure is reached within two minutes from a cold start.

The cleaner can be changed over in less than two minutes for use as a heat generator, with heat output equivalent to a 25 horsepower boiler. The change is completed by loosening two bolts and reversing crank arm. The unit is then ready for such jobs as heating tanks of viscous fluids.

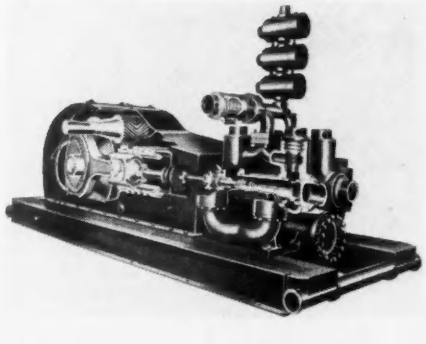
It is made in trailer mounted, portable, and stationary models. Standard equipment includes one one-half inch Hypower cleaning gun, one 25-foot length each of ½- and ¾-inch vapor hose, and a choice of either gasoline engine or one-horsepower electric motor. The unit weighs approximately 1600 pounds, measures 48 inches wide by 44 inches high, and varies in length from 78 to 132 inches, depending on the model chosen.

For additional information, write for Form SUP-100, Homestead Valve Manufacturing Company, Coraopolis, Penn., *referring to* World Oil *item* 95.

96—Duplex Power Slush Pump

This item supplements Emsco Derrick & Equipment Company data as shown on pages 1437-1556 of Composite Catalog, 17th Edition.

A large duplex power slush pump for the specialized mud-circulating requirements of deep drilling has an 8¼-inch maximum liner diameter, 18-inch stroke, and is rated at 850 horsepower input at 60 revolutions per minute. It is capable of delivering 933 gallons per minute at 1328 pounds per square inch with 8¼-inch liners.



The single pump, the D-850, delivers a range of mud-pressures and volumes previously obtainable only by compounding two power pumps of smaller capacity.

Cast steel fluid end and fabricated steel power end reduce pump weight and retain strength. Instead of the conventional studded construction, valve pot covers and cylinder heads are held to the cylinders by heavy, coarse-pitch threads in order to reduce size of openings and over-all bulk and weight of fluid end. This facilitates maintenance work since valve pot covers and cylinder heads can be removed or installed in less time.

"Exposed" liner design eliminates fluid end "washouts" caused by liner packing failure. Liners are packed-off at both ends and completely exposed to view. Small mud leaks through or around the liners may be detected while pump is in operation. Metal-to-metal shouldering of liners prevents longitudinal movement of liner.

The pump is cradle-mounted on a four-runner skid, eight feet wide by 20 feet long.

For additional information, write Emsco Derrick & Equipment Company, P. O. Box 2098, Terminal Annex, Los Angeles, *referring to* World Oil *item* 96.

97—Safety Relief Valve

This item supplements Kinzbach Tool Company, Inc., data as shown on pages 2653-2672 of Composite Catalog, 17th Edition.

"Snap open" and "snap shut" action is provided by the Model 112 safety relief valve, for instantaneous pressure relief at maximum volume of the mud pump. A detention wedge and sleeve and controlled thrust restraining springs permit the action.

The valve snaps open for instantaneous relief at full volume and a pressure less than overload pressure holds it open until a pre-determined pressure drop causes it to snap shut and restore circulation. Within a normal range adjustments in pressure settings may be made by changing the detention wedges.

All critical elements are made of corrosion resistant materials or are given anti-corrosion treatment. No fluid comes into contact with the control elements. All fluid passages are designed to provide a minimum resistance to flow.

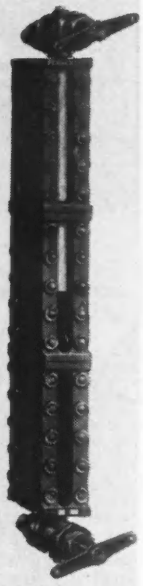
The valve may be used for any mud pump relief service, including compounding operations. It is made in the two-inch size only, for working pressures from 750 to 2500 pounds per square inch.

For additional information, write for Bulletin 11250, Kinzbach Tool Company, Inc., 2411 Summer Street, Houston, *referring to* World Oil *item* 97.

PENBERTHY
Liquid Level GAGES

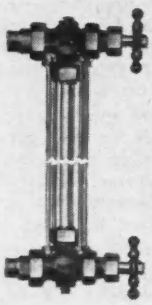
REFLEX

Reflex type complete with gage valves. Liquid shows black—empty space shows white. Liquid level is always unmistakable.



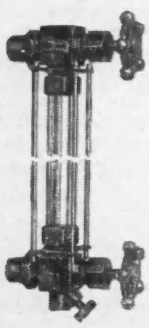
TRANSPARENT

Transparent type complete with gage valves. Used where through vision is desired under high pressures and/or temperatures.



DROP FORGED STEEL

Tubular glass type, Chrome-Moly temperature resisting steel body, stainless steel trim, regrinding removable seats.



ALL IRON

Tubular glass type, extra heavy body of special high strength alloy iron, shanks alloy steel, trim stainless steel, valves self-cleaning.

There is a Penberthy Gage of superior quality for every liquid level gage requirement. Gages are fabricated to customer's specifications from special alloys to meet unusual corrosive and temperature conditions. All Penberthy Gages conform with API-ASME requirements.

3277-B

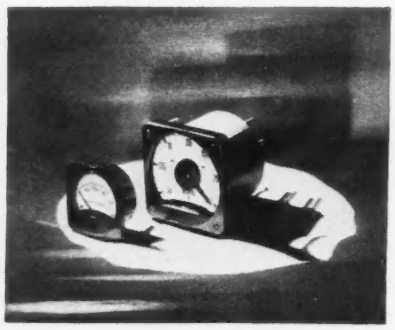
PENBERTHY INJECTOR CO.
Detroit 2, Mich.
Canadian Plant — Windsor, Ontario

NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

98—Temperature Indicators

This item supplements General Electric Company data as shown on pages 1809-1820 of Composite Catalog, 17th Edition.



Cold-end compensated thermocouple thermometers for measuring temperatures up to 3000° F. and resistance thermometers for temperatures up to 300° F. are included in a new line of temperature indicators for industrial and laboratory use.

The thermocouple thermometer is available in two sizes: the Type DO-71 with a 3½-inch flange and the DW-71 with a 2½-inch flange. Both types are available in either square or round molded Textolite cases.

For measurement of low temperatures where high accuracy is important, the resistance thermometers are available in two standard types: the DB-15 long-scale instruments and the Types DD-6 and DD-7 six-inch rectangular, surface- and flush-mounted instruments.

For additional information, write for Bulletin GEC-565, General Electric Company, Schenectady 5, N. Y., *referring to* WORLD OIL *item* 98.

99—Generating Plants

This item supplements D. W. Onan & Sons, Inc., data as shown on pages 3878-3879 of Composite Catalog, 17th Edition.

Five new models of diesel-driven electric generating plants, equipped with automatic voltage regulators, range from 12½ to 55 kilowatts.

Powered by International Harvester low-speed engines, the units combine all-weather gasoline engine starting with full diesel operation. The engine is cranked by a 12-volt starting system similar to any conventional gasoline engine. Less than a minute of warmup is required before changing over to full diesel operation, by means of a control lever. A battery recharging generator is provided to maintain starting batteries at full charge.

The new models are available in all standard voltages, frequencies and phases. They are equipped with permanently aligned voltage regulated type generators. Generators may be paralleled.

Basic models are furnished with necessary engine and generator controls, automatic voltage regulator and running time meter. Standard equipment includes exhaust muffler, battery cables and terminal box. Optional equipment includes voltmeter, ammeter, circuit-breaker, paralleling equipment, high water temperature and low oil pressure alarm or cut-off, steel skid base, battery rack, exhaust snubbers and fuel tanks, and fuel lines with fittings.

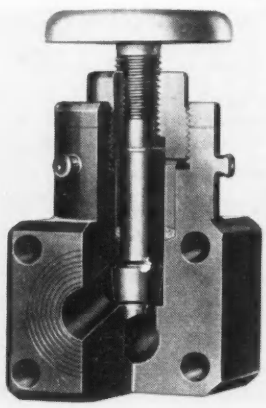
For additional information, write D. W. Onan & Sons, Inc, 3621 Royalston Avenue, Minneapolis, Minn., *referring to* WORLD OIL *item* 99.

100—Globe Valve

This item supplements Union Carbide and Carbon Corporation data as shown on pages 2190-2191 of Composite Catalog, 17th Edition.

Shutoff and throttling service with corrosive fluids free from abrasive solids is provided by a new "Karbate" impervious graphite globe valve. Except for the Teflon packing, all valve parts in contact with the fluid are of impervious graphite to prevent corrosion and contamination.

The valve is resistant to practically all corrosive chemicals, including hydrochloric acid, and to thermal shock. The valve may be heated from a steam coil of copper tubing wrapped around it, when heating is required for handling highly viscous or saturated solutions. The tapered disc valve seat is self-reseating.



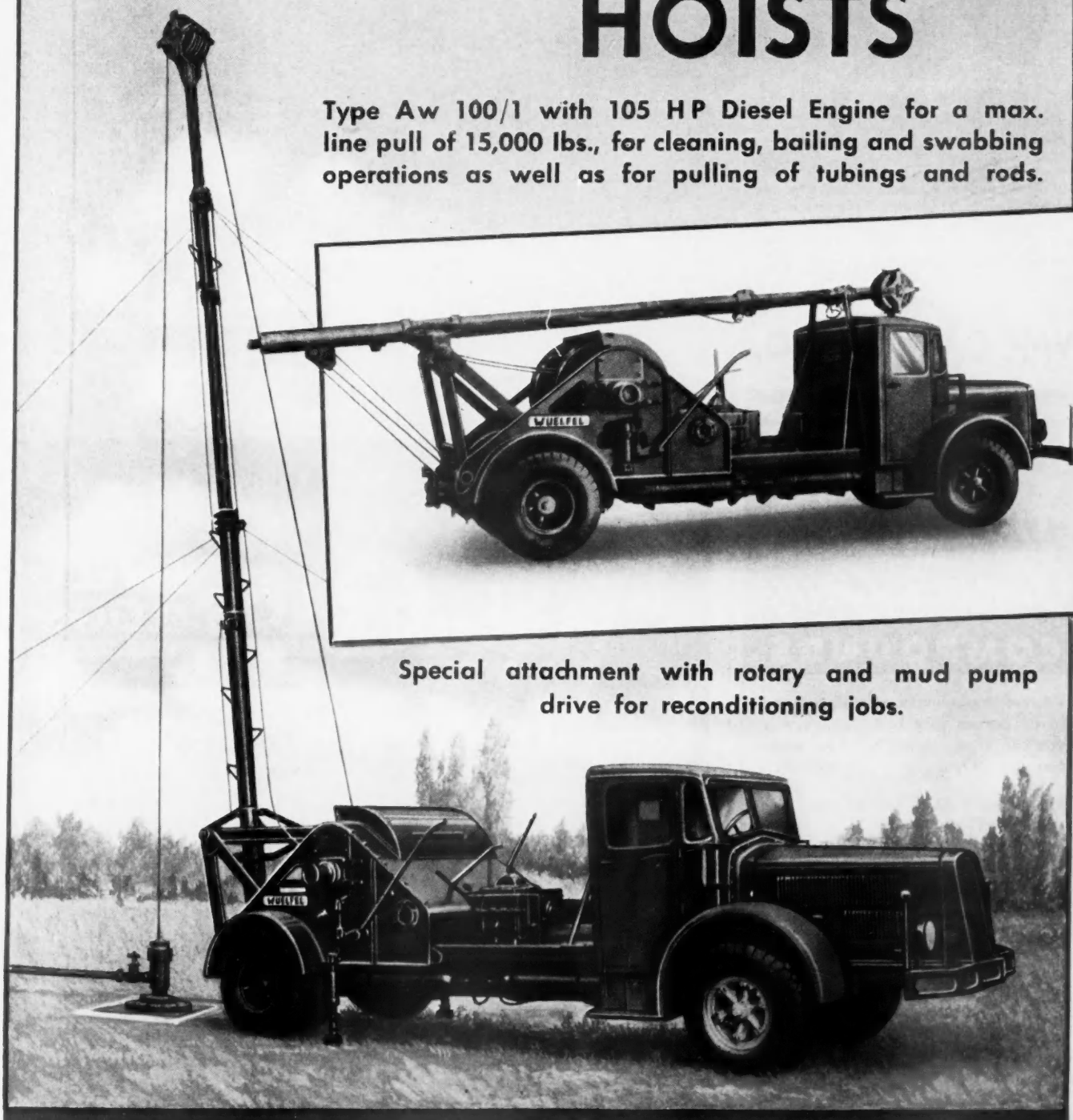
For additional information, write for Catalog Section M-8803A, National Carbon division, Union Carbide and Carbon Corporation, 32 East 42nd Street, New York 17, *referring to* WORLD OIL *item* 100.

Wilfel

TRUCK MOUNTED HOISTS

Type Aw 100/1 with 105 HP Diesel Engine for a max. line pull of 15,000 lbs., for cleaning, bailing and swabbing operations as well as for pulling of tubings and rods.

Special attachment with rotary and mud pump drive for reconditioning jobs.



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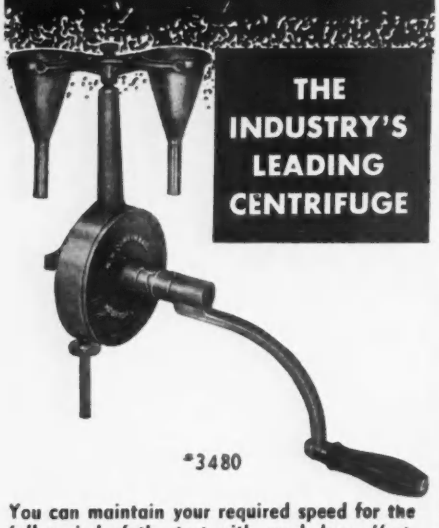

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NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

101—Thread Protectors

This item supplements S & R Tool & Supply Company data as shown on pages 4369-4376 of Composite Catalog, 17th Edition.

Two types of thread protectors facilitate safe and easy handling of drill collars and subs. The protectors are made one-half inch larger in diameter than the joint for which they are furnished, so that wear and damage in handling are taken by the protector, not the joint.

Made of cast steel, they are machined to specification, and will make up as any tool joint. The lifting eye is cast integrally with the body and provides ample room for winch line or cat line.

The protectors are available for any standard tool joint thread from 2⅞ through 6⅝ inches. All threads are cut extra long to accommodate long joints on collars or subs.

For additional information, write S & R Tool & Supply Company, Beaumont Highway, Houston, *referring to* WORLD OIL *item* 101.

102—Slush Pump Liners

This item supplements Weatherford Oil Tool Company, Inc., data as shown on pages 4917-4936 of Composite Catalog, 17th Edition.

New forged steel slush pump liners are available for all standard makes of slush pumps. The forgings are uniformly heat-treated in a flame-hardening machine, and are machined inside and out.

The liners are steam-cleaned and sprayed with chrome-aluminum paint. A semipermanent corrosion-proofing compound is applied to the inner surface.

For additional information, write Weatherford Oil Tool Company, Inc., Weatherford, Texas, *referring to* WORLD OIL *item* 102.

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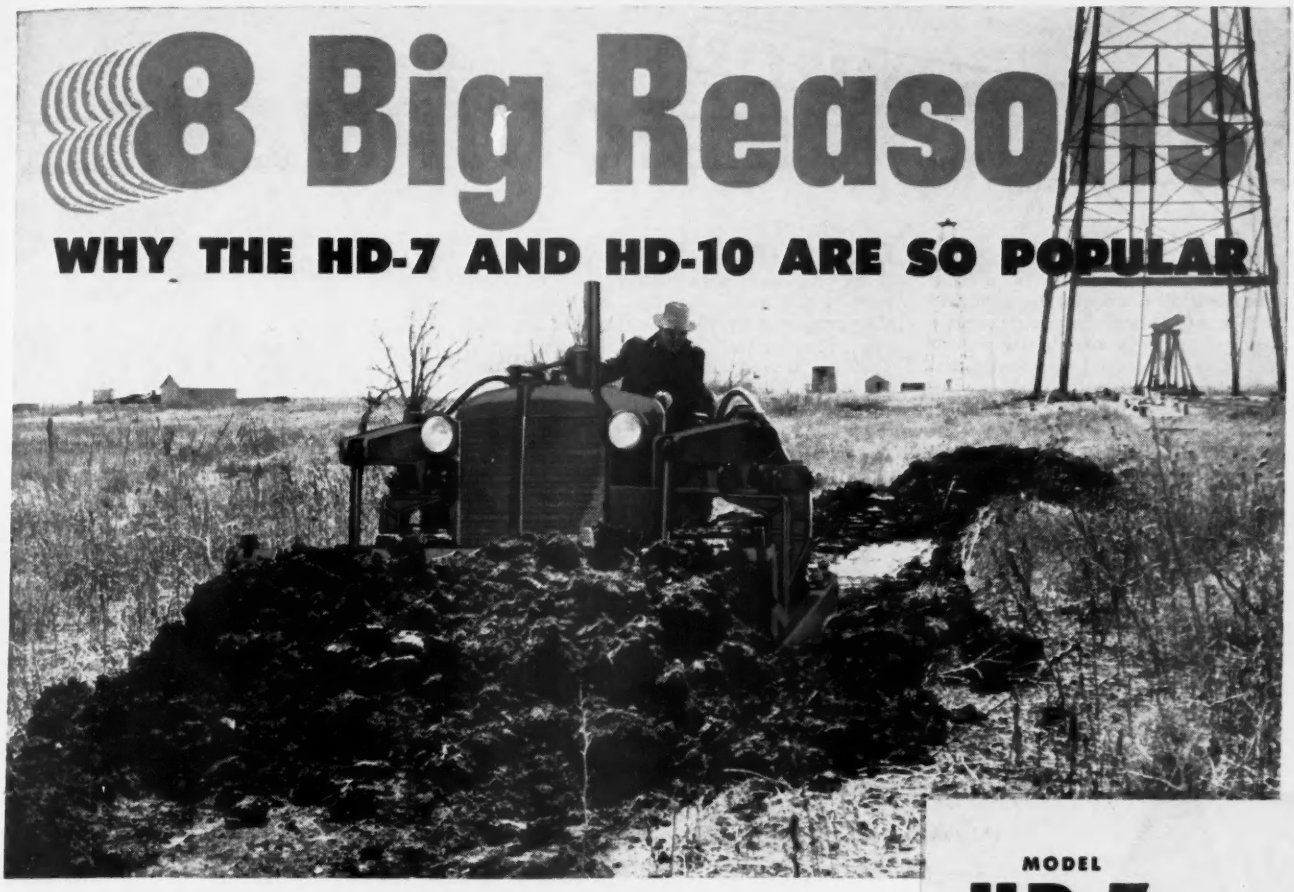
MIAMI, OKLAHOMA MIDLAND, TEXAS

8 Big Reasons

WHY THE HD-7 AND HD-10 ARE SO POPULAR



1,000-HOUR LUBRICATION of truck wheels, support rollers and idlers. You operate six months on a 40-hour week basis with just *one lubrication* . . . instead of daily, or even weekly, attention. Think what this means in labor and lubricant savings . . . and in working time gained! Think of the safety factor, too — no costly damage by greasing neglect.

GENERAL MOTORS 2-CYCLE DIESEL ENGINE Rugged, simple, economical, "hanging-on" power. Smooth — every down stroke a power stroke . . . less wear and tear on tractor and operator. Far less power loss than other engines at high altitudes.

INTERCHANGEABLE ENGINE PARTS Nearly all of the GM engine wearing parts are interchangeable with each of the GM engines on the various models of A-C tractors and motor graders — no matter the size. Lowers parts investment, simplifies maintenance for Allis-Chalmers fleet owners.

INSTANT STARTING GM 2-cycle diesel engines start as easily as your automobile . . . and they *start* and *operate* on *diesel fuel*. No need to let 'em idle during work-stop periods — no unnecessary engine wear or fuel waste.

FAST MANEUVERING 2-cycle diesel tractors are well known for their fast-working ability — not only for quickly traveling from cut to fill, but for turning around instantly in their tracks . . . and for easy maneuvering in and around tight places — especially important on bulldozing. Time saved is money made!

PROPER BALANCE Weight, speed and power are positively balanced in A-C tractors, assuring top performance on every job — pulling, pushing, lifting.

OPERATOR COMFORT All these advantages mean operator satisfaction, too — resulting in more work done, more easily. Besides — he has a big, wide, comfortable seat, cushioned back, arm rests, roomy platform, convenient controls, good vision.

MATCHED ALLIED EQUIPMENT Each Allied manufacturer, skilled in his own field, works in complete cooperation with Allis-Chalmers in designing and building auxiliary equipment.

MODEL

HD-7

(shown here)

60.10 drawbar hp. Four speeds forward, to 5.00 m.p.h.; reverse to 1.89. Weight: 52" tread, 13,830 lbs.; 63" tread, 14,000 lbs. Available with large idler.

MODEL

HD-10

86.63 drawbar hp. Six speeds forward, to 6.03 h.p.h.; two reverse, to 4.15. Weight 62" tread, 21,000 lbs.; 74" tread, 21,600 lbs. Available with large idler.

ASK ANY OWNER . . . OR ARRANGE FOR A DEMONSTRATION . . .
"SEEING IS BELIEVING"

ALLIS-CHALMERS
TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

OTHER NEW AND IMPROVED EQUIPMENT

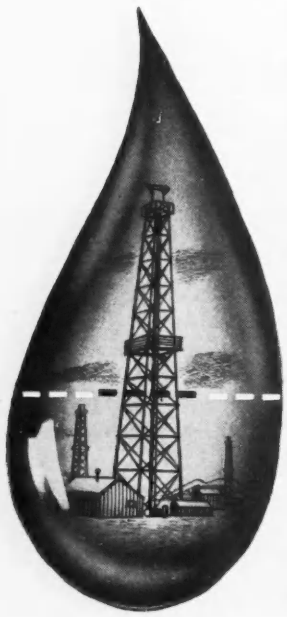
103—Scale Remover

"Doctor Boiler" prevents the accumulation and removes boiler scale primarily by a physical process which the manufacturers have described as "colloidizing." A microscopic film covers the inside of the boiler and is said to seal off the moisture and chemical action of the water from the scale. The scale then dries out, and the expansion and contraction of the metal together with the peptizing action of the solution causes the scale to drop out. "Doctor Boiler" is also said to prevent corrosion and foaming.

For additional information, write Doctor Boiler, Inc., 4316 Main St., Dallas, *referring to* WORLD OIL *item* 103.

First in

CANADA'S OIL FIELDS



The Royal Bank of Canada can answer your questions about Western Canada's fabulous oil development whether you are interested in oil financing in any of its aspects or wish sound advice on establishing business connections in Canada.

The Royal Bank has had branches in Canada's oil fields since the earliest days. Our branch in Turner Valley was opened in 1928 — in Leduc, we opened just one day after the first producing well was completed— in Devon and Redwater, our branches opened last spring. So closely identified has this bank become with Canada's oil development that it has become known as "Canada's oil bank."

Please address your enquiries to—
E. B. Durham, Supervisor,
The Royal Bank of Canada
Calgary, Alberta

CANADA'S "OIL" BANK

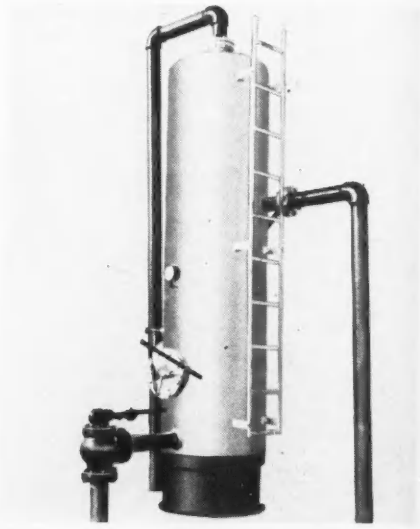
See the Royal about Canada's oil

55 Branches in Alberta, the "oil" province. Over 720 branches in Canada, the West Indies, Central and South America. New York, London, and Paris. Head Office, Montreal.

ASSETS EXCEED $2,334,000,000

THE ROYAL BANK OF CANADA

104—Separator



Centrifugal force is generated and used as an aid to separation in a new vertical-type low pressure oil and gas separator. A maximum metal surface is provided for the capture of oil droplets and the release of gas bubbles, in the centrifugal mist extractor at the top of the separator shell, and in the fluid stabilizer section, at the vessel's waist.

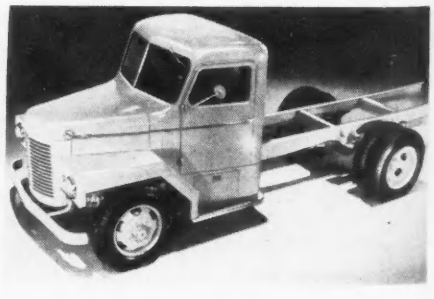
Vertical construction of the separator, which is built in seven sizes, permits tangential oil entry, to generate immediate centrifugal force.

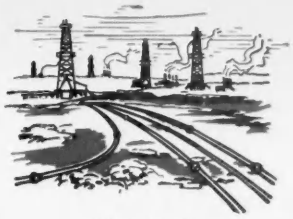
For additional information, write Sivalls Tanks, Inc., Odessa, Texas, *referring to* WORLD OIL *item* 104.

105—Light Truck

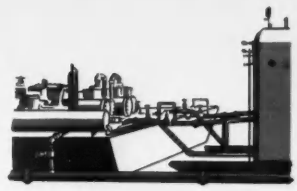
A four-wheel drive truck is adapted for light service which requires the added traction of four wheel drive design. The new truck, Model LD, has a gross vehicle weight of 14,500 pounds.

For additional information, write The Four Wheel Drive Auto Company, Clintonville, Wis., *referring to* WORLD OIL *item* 105.

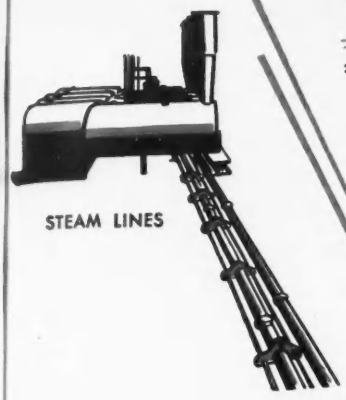




FIELD LINES

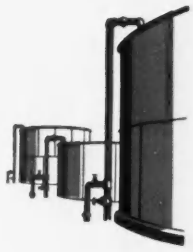


WATER LINES

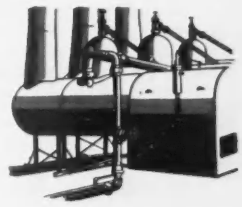


STEAM LINES

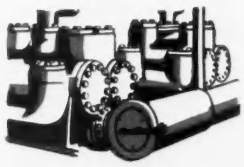
SEPARATORS



TANK BATTERIES

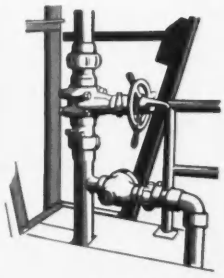


BOILER HEADERS

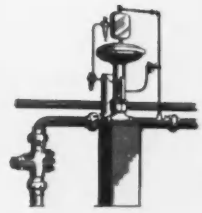


SLUSH PUMP STRAINERS

XMAS TREES



MUD LINES



REGULATOR MANIFOLDS

MAKE THE MOST OF A GOOD THING—UNIBOLT!

. . . the perfect coupling for drilling and production service

There is no limit to the uses for UNIBOLT Couplings in drilling and production service. Any line — steam lines, water lines, mud lines, oil and gas lines — can be coupled tighter, with a stronger joint, and dismantled and re-assembled in fast time with UNIBOLT Couplings. Three types of seats: a metal ring gasket type for high pressure service, a renewable resilient type for saturated steam and low pressure oil, gas, or water lines, and a tongue and groove type which conforms to ASA-600 Series specifications for welding neck couplings. Hubs are provisioned for threaded, socket weld, or butt weld connections. The pressure range is up to 15,000 lbs. test.

So, you name the coupling job and UNIBOLT will furnish the coupling designed expressly for that job. Make the most of a good thing . . . UNIBOLT.

THORNHILL-CRAVER CO.

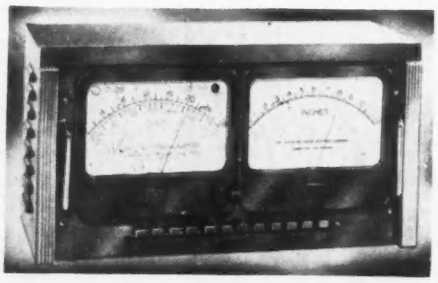
HOUSTON, UNIBOLT THE ONE BOLT COUPLING TEXAS

106—Remote Gauge

The new "Varec" electronic gauger duplicates tank readings at any remote position. Readings may be made at more than one remote location by installing receivers at convenient positions.

The front panel of each receiver has two dials; give feet and inch indications. Receivers are designed for use on 110-115 volt, 50-60 cycle alternating current power. Transmitters may be installed on most types of float-actuated tank gauges, and are explosion-proof.

For additional information, write The Vapor Recovery Systems Company, P. O. Box 231, Compton, Calif, *referring to* World Oil *item* 106.



107—Ladder Safety Device

Lost production because of dangerous, icy tower ladder conditions can be averted with the Tower Safety Ladder Device.

The device consists of six parts: the 1¼-inch pipe, which runs the full length of the structure, and has a tensile strength of 52,500 pounds; the sleeve, with tensile of 65,000 pounds; the pin, tensile 27,000 pounds; studs, which secure the device to the structure, and will stand a weight of 800 pounds dropped five inches; the cable, which carries approximately 12 pounds, has a breaking strength of 600 pounds; and the chain and snap which attaches to the safety belt, tested to 2000 pounds. The safety belt is of the web type and of comparable strength.

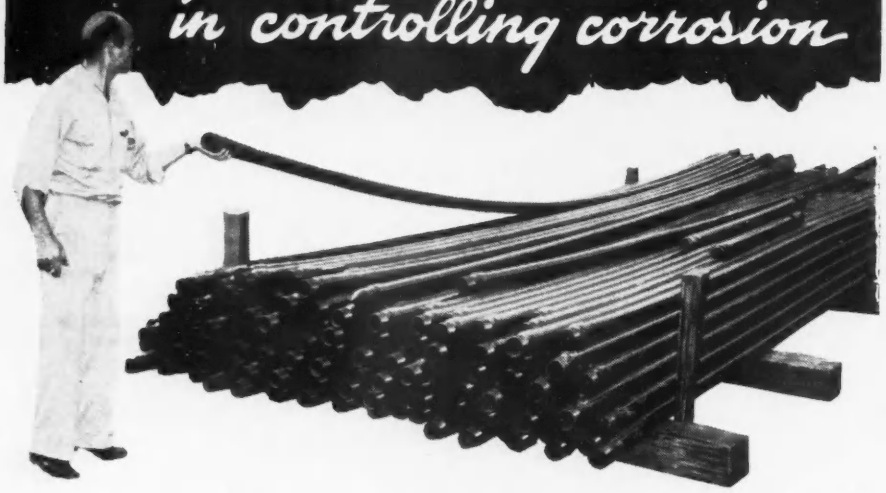
For additional information, write Safety Tower Ladder Company, Suite 1210, Shoreham Building, Washington, D. C., *referring to* World Oil *item* 107.

108—Abrasive Saw

A wheel which is abrasive throughout the body of the blade rather than on the cutting edge alone enables a new abrasive saw to score heavy cast iron pipe. Blocks or rollers can be attached to the front and back of the standard saw base to make it seat properly on a curved surface. The abrasive wheel can be adjusted for the cut with a micrometer set screw, from 0 to 45 degrees.

For additional information, write Porter-Cable Machine Company, 100 Wolf Street, Syracuse 8, N. Y., *referring to* World Oil *item* 108.

CARLON "B" IS BASIC in controlling corrosion



Carlon "B" Plastic Pipe prevents corrosion in transmission lines and disposal tubing

CARLON "B" PLASTIC PIPE is practical and economical where corrosion is a factor. It's easy and economical to handle because it makes up fast and is light in weight. Many operators are using it successfully for flow lines, full lines, gathering lines, siphons and disposal tubing.

Field installations of sour crude lines, salt water disposal tubing, and many other applications, have proved its merit under a wide range of climatic conditions.

This plastic pipe resists corrosion both internally and externally in various soils, gases, and liquids that ordinarily affect other tubular material.

JUST OFF THE PRESS!

We will gladly forward you a copy of "How To Control Corrosion with Carlon B" upon request. No obligation, of course.

GREEN CONTRACTING AND ENGINEERING CO.
120 SOUTH VINE . . WICHITA, KANSAS
CARTER PRODUCTS CORPORATION, CLEVELAND, OHIO, MFRS.

MIGHTY MOLARS THAT BITE DEEP AND FAST

USE ATLAS SI-MO STEEL BALLS

Appleby Rock Bits . . . manufactured by Engineering Laboratories, Inc., Garland, Texas . . . bite deep and fast to the oil sands perhaps a mile or more down. It's a tough job they tackle . . . but they've earned their reputation for stamina and durability.

Part of their inherent bulldog quality is due to the use of ATLAS SI-MO Steel Balls. ATLAS SI-MO Steel Balls are machined to ±.0002-in. accuracy and are made from carefully selected Silicon-Molybdenum steel. When readings are taken on the parallel flats, hardness is Rockwell 53 to 59 C Scale. 13 sizes, ranging from ¼-in. to 1-in.

Here again is proof that continuing engineering and metallurgical research plus rigid control of every manufacturing process enables ATLAS to anticipate the demands of industry. ATLAS BALL DIVISION, SKF Industries, Inc., Philadelphia 32, Pa. 7071

8 REASONS WHY SKF IS PREFERRED BY ALL INDUSTRY

INTEGRITY — CRAFTSMANSHIP — METALLURGY — TOLERANCE CONTROL

SURFACE FINISH — PRODUCT UNIFORMITY — ENGINEERING SERVICE — FIELD SERVICE

SKF

BALL AND ROLLER BEARINGS

Pioneers of the Deep Groove Ball Bearing – Spherical Roller Bearing – Self-Aligning Ball Bearing

THIS TUBING SPEAR WILL SAVE YOU *MONEY!*

The Pioneer Releasing Tubing Spear is a good tool to have on the lease in case of a fishing job. It will pay for itself in time saved in getting your well back in production.

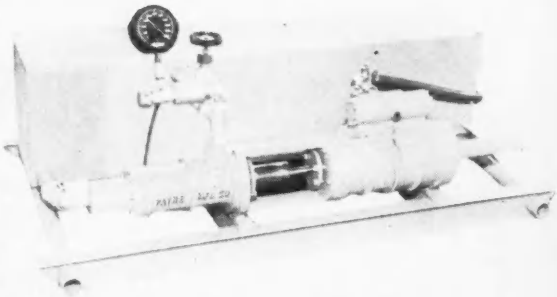
Because of its simple, positive releasing mechanism, the Pioneer Releasing Tubing Spear can be used by your production crew and does not necessitate calling in a special service organization.

Warranted in every respect, this tool has been proved through years of use by a leading well service company. Now you can buy it to be used by your own production crew. Send for prices and descriptive literature.

PIONEER WELL TOOLS, Inc.
424 Hogan St. Phone: FAirfax 4768
HOUSTON, TEXAS

OTHER NEW EQUIPMENT

109—Blowout Preventer Closing Unit



A new method for closing hydraulic blowout preventers is provided with a new unit which includes a double-acting reciprocating pump with only two moving parts. It uses no rocker arm or cross head and is automatic.

The double acting fluid end has only two valves. External rod packing is provided. Operating on 125 pounds per square inch on gas, air or steam, it obtains a discharge pressure of 5000 pounds per square inch.

For additional information, write Payne Manufacturing Company, 7329 Canal, Houston, *referring to* WORLD OIL *item* 109.

110—Sheathing

A new molded sheathing for pipe line pipe prevents damage to pipe wrappings during the process of lowering the pipe into the trench. This sheathing, known as Leatherback asphalt molded hardboard, is formed into semicircular shape and is placed around the pipe and held in place by steel strapping. It is supplied in a full range of widths for pipe up to 36 inches diameter.

Available in thicknesses of ⅛, 3/16 and ¼-inch, it resists tearing or galling, or fracture of the pipe wrapping by the sling or other apparatus used to lower the pipe.

For additional information, write Protective Papers, Inc., Union, Ill., *referring to* WORLD OIL *item* 110.

EXCLUSIVE EXPORT DISTRIBUTOR
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PARKERSBURG MACHINE Co. PARMACO PARKERSBURG, W. VA. U.S.A.

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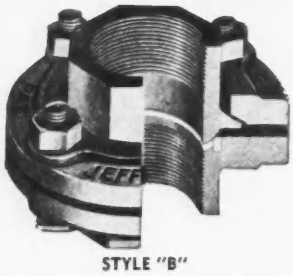
SEE OUR CATALOG IN COMPOSITE CATALOG

PARKERSBURG MACHINE COMPANY
PARKERSBURG, W. VA.

Jefferson Malleable Unions



STYLE "B"

JEFFERSON Style "B" three-piece flange union is made with brass-to-iron and iron-to-iron seats. Being made of highly refined AIR FURNACE iron. it assures you of lightweight construction, perfect ball joint, and positive seating arrangement, whether or not in alignment.

★ ★ ★

HYDRAULIC PRESSURE RATING

Sizes	Test Pres.	O. W. G.	S. W. P.-550 Deg.
½" thru 4"	2000#	800#	250#
5" and 6"	1200#	500#	250#
8" and 10"	1000#	400#	250#

Malleable iron used in all JEFFERSON unions meets ASTM 4733, Grade 35018—M. T. 53000 Lbs., giving 75% more elongation 50%-more impact value and is 30%-stronger than cupola malleable iron.

Obtainable through your jobber

Jefferson Union Company, Inc.

691 West 26th St.,
New York 1, New York

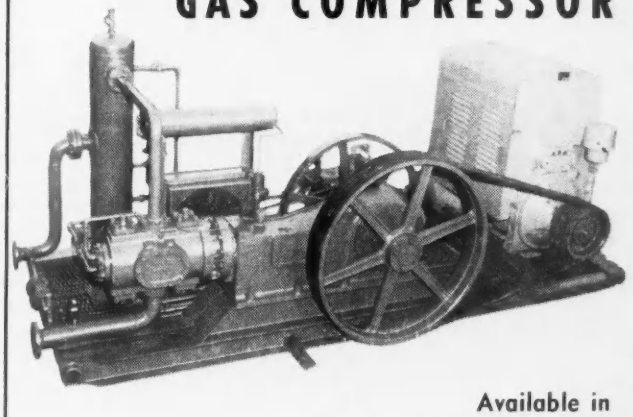
71 Gooding St.,
Lockport, New York

31 Fletcher St.,
Lexington, Mass.

WORTHINGTON

PORTABLE

GAS COMPRESSOR



Available in
Capacities to 7,500,000 CFM
and Pressures to 1600 Pounds

For your requirements, consult our nearest office or Distributor

A. M. LOCKETT & COMPANY, LTD.

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It's the **NIGHT WORK** *We like*

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714 Fourth Nat'l Bank Bldg. ▪ Wichita, Kansas

This Famous Resort Gives You

SUNNY DAYS

HAPPY HOURS

★

AIR CONDITIONED
FOR HEALTH
AND
COMFORT

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Rooms from $3.

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BAKER HOTEL

The ultimate in facilities for recreation and rejuvenation. Other outstanding features include the finest in therapeutic baths with complete massage. Luxurious accommodations. Beautiful grounds with an eighth-mile sun veranda. Outdoor activities at their best.

Listed by committee on American Health Resorts of the American Medical Association

MINERAL WELLS, *Texas*

Here's the Accurate Way to take Wire Line Measurements

Easy to use

•

Light and handy to carry

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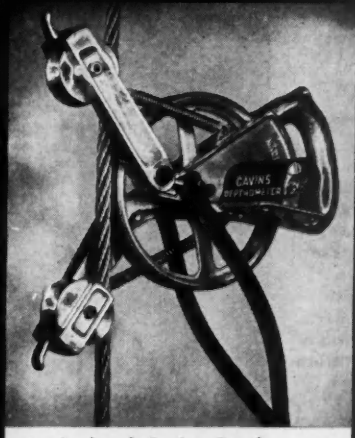
No more "Stringing-in" Guess Work

•



Gives you accurate depth

•

Direct reading

•

Pays for itself in a short time

•

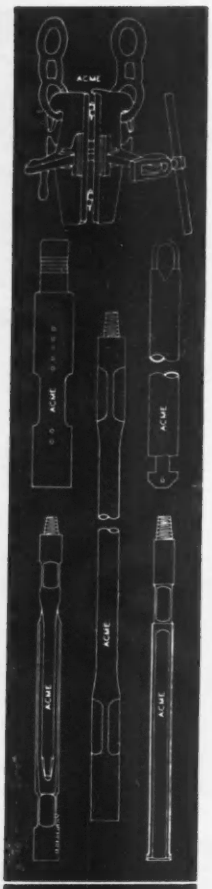
Hundreds of Cavins Depthometers are in successful service giving their owners direct-reading, accurate well measurements. This strong, simple device comes in a handy carrying case (weighs only 17 pounds)—is put on the line in a few seconds, and tells you where bottom is quickly and dependably. —Write for folder to The Cavins Co., 2853 Cherry Ave., Long Beach 6, California.

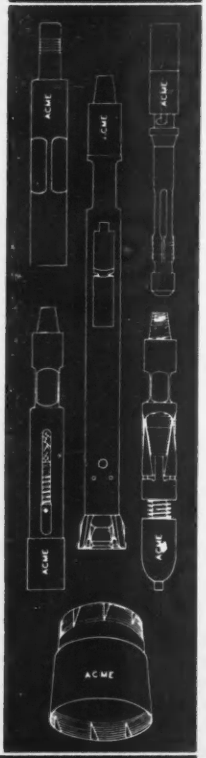
THE CAVINS DEPTHOMETER

50th Acme Anniversary

Having met a half-century's vicissitudes . . . attained and held a position of leadership . . . Acme still perseveres for perfection—as designers and manufacturers of:

DRILLING and FISHING TRUSTWORTHY Cable Tools





See Acme's latest condensed Catalog and tool-use Manual in Composite Catalog (up front—in Vol. 1). Or mail penny postal TODAY for your copy. Cover-to-cover full of valuable information for Cable Drillers.

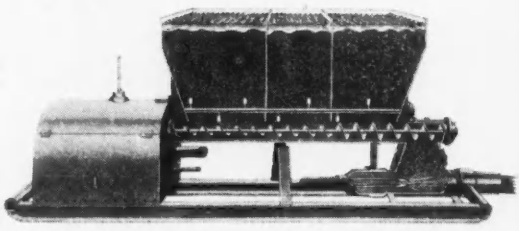
ACME DRILLING & FISHING TOOLS

Since 1900—this familiar symbol has assured more hole-footage per tool dollar.

ACME FISHING TOOL CO.
PARKERSBURG W. VA.
Export Office:
19 Rector St., New York 6, N.Y.

OTHER NEW EQUIPMENT

111—Three-Compartment Mud Mixer

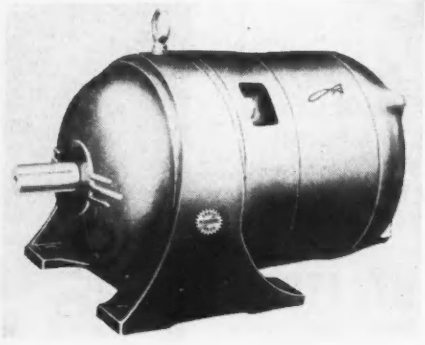


A new mud mixer has a 30-sack screen bin with three compartments for different materials. Using its four-speed feed, it can mix as many as 20 sacks a minute or as few as 2½ sacks per hour. Drive can be either electric or steam.

The mixer operates with a mud pump connected to an inlet on its mixing chamber. Conveyor screw regulates amounts of material fed from the compartments.

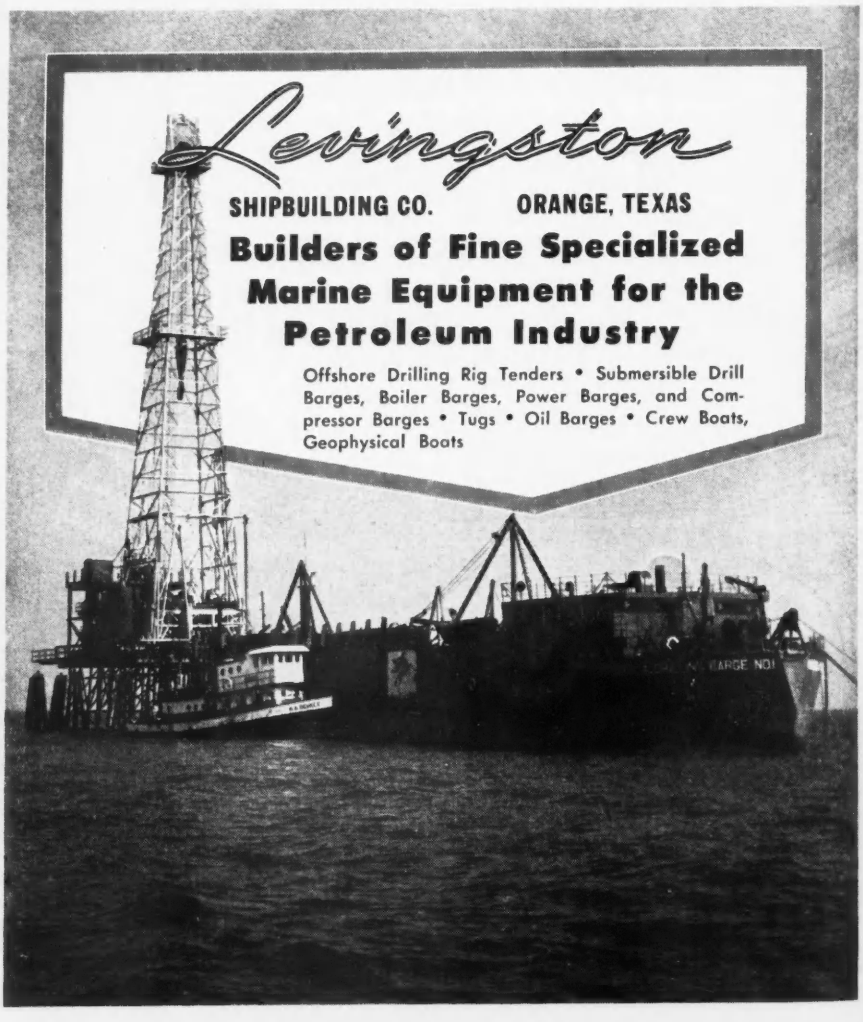
For additional information, write Republic Supply Company, National Standard Building, Houston, *referring to* WORLD OIL *item* 111.

112—Gearmotor



Helical gears and other moving parts of a new line of gearmotors are processed and heat treated under new methods. Manufactured in 17 sizes, the gearmotor is available in single, double and triple reduction units having output speeds from 780 down to 7.5 revolutions per minute. Integral horsepower ratings from 1 through 75 horsepower are available.

For additional information, write Foote Brothers Gear and Machine Corporation, 4545 South Western, Chicago, or Louis Allis Company, 427 East Stewart Street, Milwaukee 7, *referring to* WORLD OIL *item* 112.


Levingston
SHIPBUILDING CO. ORANGE, TEXAS
Builders of Fine Specialized Marine Equipment for the Petroleum Industry
Offshore Drilling Rig Tenders • Submersible Drill Barges, Boiler Barges, Power Barges, and Compressor Barges • Tugs • Oil Barges • Crew Boats, Geophysical Boats

FOR DEEP OR SHALLOW DRILLING...

GEOLOGRAPH

MECHANICAL WELL LOGGING SERVICE CAN HELP YOU!

Even in *shallow* drilling, you save when you log as you drill with Geograph. You make it as "painless" as possible because Geograph's foot-by-foot record shows when the bit is dull; gives more hole per bit and in less time; shows depth, connections and down time!

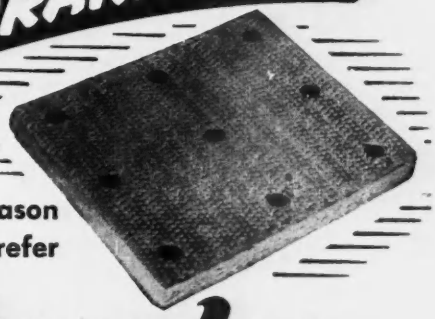
ODESSA, TEX. • WICHITA FALLS, TEX. • BAKERSFIELD, CALIF.
SHREVEPORT, LA. • BATON ROUGE, LA. • CASPER, WYOMING

"TIME WILL TELL"

THE GEOLOGRAPH CO. INC.

P. O. Box 1291 Oklahoma City 1, Okla.

SMOOTHNESS OF BRAKING...



... another reason why drillers prefer

Standco NO-SMOKE BRAKE LINING

There's no grabbing when Standco Lining is used. It has a nice feed-off and slight lever pressure controls the heaviest strings of pipe.

More deep wells have been drilled with Standco than with all other blocks combined.

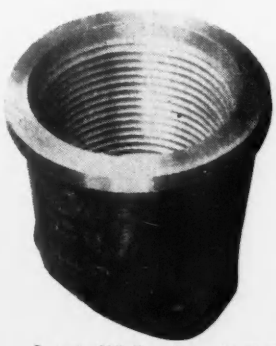
Be sure Standco No-Smoke Brake Lining is on all your rigs.

STANDCO BRAKE LINING COMPANY

Factory and General Offices

2701-2801 Clinton Drive Houston, Texas

S & R THREAD PROTECTORS



Save collar and sub thread damage! S & R thread protectors not only prevent damage to joints, but also provide a simple, safe and convenient means for lifting heavy drill collars and subs.

Made of cast steel, carefully machined to established specifications. They will make up and shoulder like any standard tool joint. The heavy lifting eye is cast integrally with the body of the protector . . . provides plenty of room for winch or cat lines. Available for any standard tool joint thread, from 2⅞" to 6⅝". All threads cut extra long to accommodate extra long joints on collars or subs.

Save damage . . . save money . . . the cost of recutting one thread on a collar or sub is usually more than the cost of an S & R protector.

Export: 233 Broadway, N. Y. 7, N. Y.

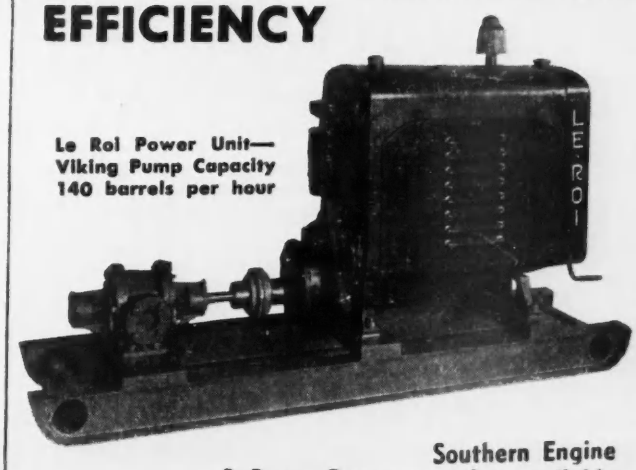
S & R TOOL & SUPPLY CO.

P. O. Box 1755 155 McCarty

HOUSTON 1, TEXAS

THE RIGHT TEAM FOR EFFICIENCY

Le Roi Power Unit—
Viking Pump Capacity
140 barrels per hour



Southern Engine & Pump Company makes available to you 40 years of "KNOW HOW" in your pumping requirements.

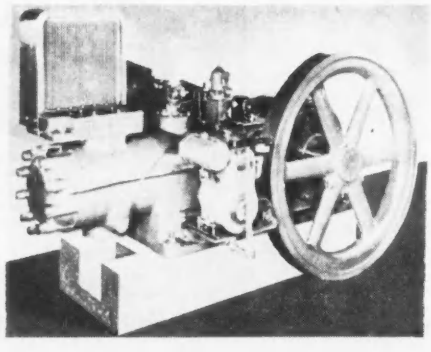
• Complete units and replacement parts at all branches.

SOUTHERN ENGINE & PUMP COMPANY

MANUFACTURERS • MACHINERY FACTORS • CONTRACTORS

Houston - Dallas - Kilgore - San Antonio
Edinburg, Texas; Houma and Lafayette, La.

113—Two-Cycle Engine



Two new horizontal type single-cylinder, two-cycle engines are identical except for cylinder bore and brake horsepower output. The Lorain Model R with 12-inch bore and 13-inch stroke, produces 45 brake horsepower at 325 revolutions per minute; Model A, with 13-inch bore and stroke, produces 55 bhp at the same speed.

Both models have tapered roller bearing crankshafts and auxiliary shafts, and wet-sleeve cylinder liners of alloy cast iron. They have condenser type cooling system.

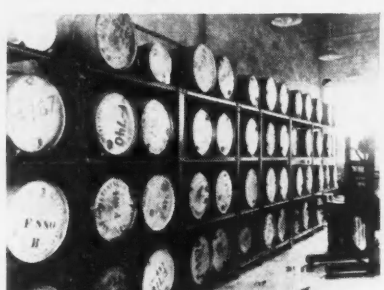
Model R operates on natural gas fuel only, and Model A can be operated as a cold-starting, full diesel or converted in the field to burn natural gas or butane.

For additional information, write White-Roth Machine Corporation, Lorain, Ohio, *referring to* World Oil *item* 113.

114—Drum Rack

Structural steel storage racks for chemical drums have all-welded panels and frames, with no punched holes to weaken the structure. The racks are available in 20-drum sections, so that storage facilities can be increased, rearranged or moved.

A portable elevator made by the same company, and a fork lift truck are used to place drums in the racks and for their removal. The racks may be used either indoors or out. Materials may be drawn from any drum without its removal from the rack, or disturbing other drums.



For additional information, write Barrett-Cravens Company, 4609 South Western Boulevard, Chicago 9, *referring to* World Oil *item* 114.

115—Power Plant

Current for a new electric light and power plant is supplied by a new type brushless, permanent magnet generator. The plant's only moving part is the permanent magnet rotor, which spins on sealed, precision ball bearings. The "burnout-proof" armature is wound with 5/16-inch solid copper rod capable of carrying three times the rated output of the unit.

For additional information, write Midwestern Engine & Equipment Company, Inc., 105 North Boulder, Tulsa, *referring to* World Oil *item* 115.

Pictured is CMC DUAL PRIME Model 39 "on the job" for Continental Pipe Line Co. Location: Ville Platte, Louisiana.

CHOOSE A DUAL PRIME—

IT'S THE CENTRIFUGAL THAT'S BETTER 4 WAYS!

- CMC DUAL PRIME PUMPS assure unmatched self-priming speed. Faster self-priming is the result of the exclusive CMC dual jet construction and advanced centrifugal design.
- CMC DUAL PRIME PUMPS give top performance even under adverse conditions. Extra air-handling ability permits constant and dependable performance when ordinary centrifugal pumps lose prime and become air bound.
- LOWER MAINTENANCE COST AND LONGER TROUBLE-FREE PERFORMANCE. When pump is worn, merely replace impeller and wear plate to obtain new pump performance.
- Maximum flexibility and versatility is a characteristic of all CMC DUAL PRIME PUMPS. Sizes available from 1½ inch to 10 inch — from capacities of 3000 to 200,000 gallons per hour.

The Sure Sign of Dependability

FREE ENGINEERING SERVICE

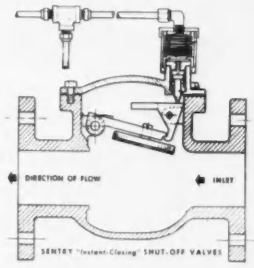
Our experienced pump engineers are ready at all times to advise you on "the right pump for the right job." We specialize in the manufacture of High Pressure Centrifugals. DUAL PRIME Centrifugals and Diaphragm pumps for the oil fields. For greater economy and best all around pump performance, *insist* on CMC. Write today for catalog.

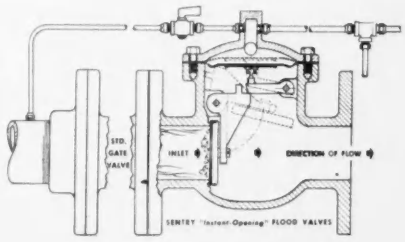
Branch Office:
1903 Blodgett Street
Houston 4, Texas
Telephone LInden-3988

CONSTRUCTION MACHINERY CO'S.
WATERLOO, IOWA, U.S.A.
The Quality Line Since 1909

OTHER NEW EQUIPMENT

116—Line Control Valves





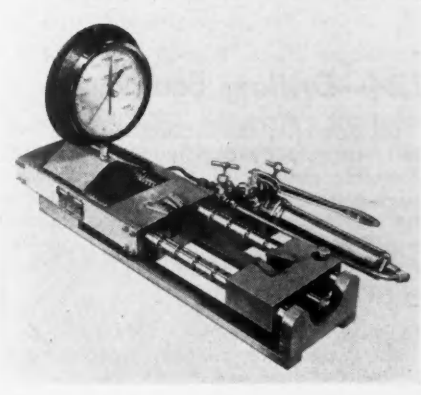
Two new Sentry valves provide automatic line control in the event of fire or other emergency. The Instant-Closing shut-off valve closes all gas, fuel oil or other "hot" lines entering the danger area. A small tube in which a nominal pressure is maintained is connected to the valve and carried to any part of the plant and the self-operating valve mechanism functions to automatically close the valve when the seal on the control line is broken.

For additional information, write McRae Valve Corporation, 620 South Main Street, Los Angeles 14, *referring to* WORLD OIL *item* 116.

117—Tensile Tester

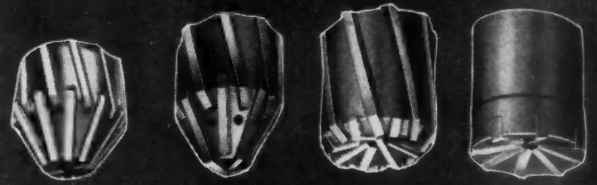
For field tests where conventional testing equipment is not available, a new portable tensile testing machine is adapted for testing pipe welds, etc. Capacity is 40,000 pounds, and the machine will make tests on specimens from six to 13 inches long and up to three-eighths inch thick and 2¼ inches wide. Operation is hydraulic, by means of a hand pump integral with base. The machine, Model PO-40, weighs 200 pounds.

For additional information, write Steel City Testing Machines, Inc., 8843 Livernois, Detroit 4, *referring to* WORLD OIL *item* 117.



KINZBACH Whipstocks and Mills-FIRST with oilmen for 24 years

Leading oil operators the world over use Kinzbach Whipstocks for side-tracking, straightening and directional drilling operations. They can be set at any depth, requiring no support for the bottom. Positive setting slips prevent slipping or turning in hole. They can be oriented to mill out in any direction. Patented hinge arrangement assures that top of Whipstock will lie close against pipe walls at all times, permitting easy passage of drilling tools. Setting trigger always locates whipstock between couplings so window will be within one joint. Available in all popular sizes of casing.



Type "A" Mill Type "D" Mill Type "H" Mill Type "I" Mill

Carefully heat-treated high-speed tool steel inserts from the cutting blades in Kinzbach Milling Tools. These inserts, set at most efficient cutting angles in properly shaped, high quality steel bodies provide unequalled cutting action and a uniform depth of cut.

KINZBACH TOOL CO., INC.
P. O. BOX 277 • HOUSTON, TEXAS

KINZBACH TOOL CO INC

Export Office:
74 Trinity Place,
New York, N. Y.

118—Welding Fittings

Sixty-five pages of technical data on welded piping systems are part of a new catalog of welding fittings. Charts, tables, graphs, condensations and discussion of pipe specifications, welding data, design formulas, metallurgical information and other engineering data are included.

Working dimensions of all welding fittings and flanges and over-all dimensions of various fitting combinations are shown in additional charts.

For a copy of this catalog, write Midwest Piping and Supply Company, Inc., Second and Barry streets, St. Louis, *referring to* WORLD OIL *item* 118.

119—Instrument Valves

Information on new drop forged steel Edward instrument valves for meter, gauge, instrument and other small lines is contained in Bulletin No. 491.

The bulletin contains dimensions, weights, prices and operating data.

For a copy of this bulletin, write Edward Valves, Inc., 1234 West 45th Street, East Chicago, Ind., *referring to* WORLD OIL *item* 119.

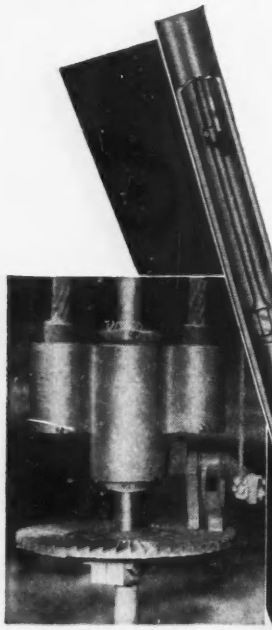
120—Fluid Drives

A progress report on the Link-Belt Electrofluid Drive, "ED" type, is presented in a new 28-page catalog and engineering data book, No. 2385.

The book covers types, sizes, arrangements and dimensions of units available, features of construction; selection tables; typical examples of fluid drive selections; and contains photographs of actual installations.

For a copy of this booklet, write Link-Belt Company, 307 North Michigan Avenue, Chicago 1, *referring to* WORLD OIL *item* 120.

WHAT ARE YOU PAYING FOR PARAFFIN REMOVAL ?



HUBER ROTATING ROD HANGER

This rod hanger rotates the rod string a fraction of a turn on each reciprocation. Two ratchet levers, operated by a flexible cable extending from the walking beam, engage the teeth in the turntable to turn the rod string.

Sold through supply stores.

TOO MUCH — If your pumping wells are not equipped with HUBER SCRAPERS

Many major companies report Huber Scrapers have completely eliminated paraffin removal costs or reduced them to only a fraction of a cent per barrel of oil produced. Huber Scrapers, shrink-fitted to new or used sucker rods, scrape the paraffin from the tubing wall as the string rotates and reciprocates. Rods are rotated by the special Huber Rotating Rod Hanger.

Reduce or eliminate your paraffin removal costs with Huber Scrapers. Write for latest bulletin.

J. M. HUBER CORP.
P. O. Box 831
BORGER, TEXAS

HUBER
PARAFFIN SCRAPERS
SCRAPE AS THEY ROTATE AS THEY RECIPROCATE

121—Oil Field Tools

A new 20-page catalog contains descriptions of all Red Devil products, including valves and seats, valve seat pullers, "Dia-Hard" liners, liner pullers, piston rods, piston pullers, Tell-Tale liner packing, etc.

For a copy of this catalog, write Oil Well Manufacturing Corporation, 6000 Alameda Street, Los Angeles 1, *referring to* WORLD OIL *item* 121.

122—Diesel Engines

Two new bulletins contain complete specifications of all automotive and industrial models of HR-600 and HRS-600 Cummins diesels. Each bulletin includes general specifications, a list of standard equipment for each model, and optional equipment. Drawings and photographs illustrate each model.

For a copy of bulletins 5287 (HR-600) and 5289 (HRS-600), write Cummins Engine Company, Inc., Columbus, Ind., *referring to* WORLD OIL *item* 122.

123—Compressors

Two new bulletins, "Pedestal Type Centrifugal Compressors," and "Centrifugal and Axial Flow Compressors," contain three articles by turbo engineers. Data are presented on applications of the gas turbine, pipe line compressors, and the expansion turbine.

For copies of these bulletins, write Clark Bros Company, Inc, Olean, N. Y., *referring to* WORLD OIL *item* 123.

124—Drilling Equipment

Illustrations, specifications, parts lists and other data are included in the 1950 complete catalog of BJ products. Discussed are hooks, links, powerslips, casing spiders, elevators, tongs, kelly bushings, tubing catchers, underreamers, core drills, parts for obsolete tools and lubrication instructions.

For a copy of this catalog, write Byron Jackson Company, P. O. Box 2017, Terminal Annex, Los Angeles 54, *referring to* WORLD OIL *item* 124.

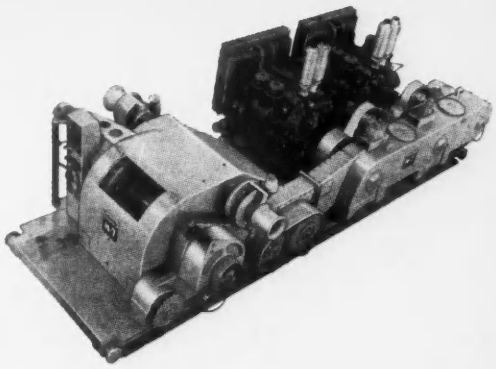
There's a BREWSTER RIG to fit any job—BETTER!

All with MATCHED EQUIPMENT

. . . to 8500'

BREWSTER **N-7**

Here's POWER to spare! Reasonable INITIAL COST, high PORTABILITY, ECONOMY of operation and maintenance has proved the N-7 fits the job of 8500' programs—better. And like all Brewster rigs, it has added advantages of perfectly MATCHED EQUIPMENT and 24-HOUR FIELD SERVICE anywhere in U. S.



6-S SWIVEL

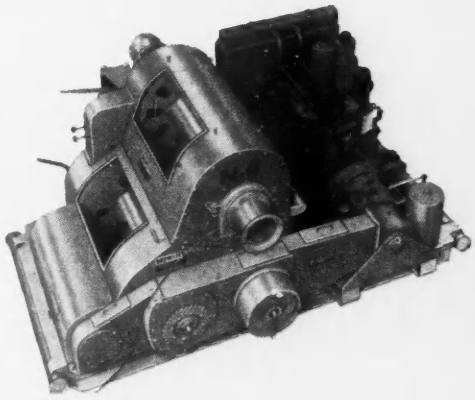
TB 200 BLOCK

RS 22 ROTARY

. . . to 5500'

BREWSTER **N-4**

SPEED and FLEXIBILITY characterize the Brewster N-4. Entirely air controlled, Torque converter(s) automatically supply maximum engine power with minimum engine effort. It's easily moved in one load. In single or double drum models—one or two engines—single or twin torque. "Hottest" rig in years.



4-S SWIVEL

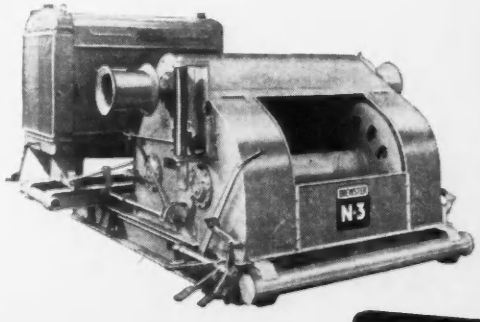
H-100 BLOCK

RS-18 ROTARY

. . . to 3500'

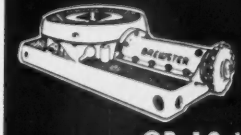
BREWSTER **N-3**

Easy to move—fast to rig up the highly portable N-3 is unitized on a single skid with all controls at driller's position. The ideal rig for shallow drilling to 3500' or deep well servicing. The N-3 is available with single or double drum. Removable front drum cover section for convenience in well servicing.



3-S SWIVEL

H-50 BLOCK



OB-12-L ROTARY

THE BREWSTER COMPANY, INC.

Manufacturers of Drilling Equipment Since 1910

SHREVEPORT, LOUISIANA

Brewster Drilling Equipment is Sold by:

APEX EQUIPMENT CO.
BOVAIRD SUPPLY CO.
INDUSTRIAL SUPPLY CO.
MURRAY BROOKS, INC.
REAMS SUPPLY CO.
HALEY SUPPLY CO.
Calgary, Canada

BREWSTER MATCHED Drilling Equipment

PETROLEUM ENGINEERS
CABLE & STINE
WICHITA FALLS, TEXAS

EXPERIENCED PRACTICAL AND TECHNICAL CONSULTING PRODUCTION ENGINEERING SERVICE

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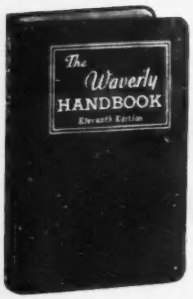
SPECIALIZING in

MODERN SECONDARY RECOVERY

Announcing . . .

THE NEW 11th EDITION



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Waverly Handbook

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Completely revised, with up-to-the-minute production and price data never included in previous editions.

More than 850 pages of important technical, engineering and chemical information pertaining to every phase of the Petroleum Industry. Written and compiled by leading Petroleum Engineers and technical authorities in the United States and Europe . . . **THE ONLY BOOK OF ITS KIND PUBLISHED TODAY!**

In addition to its value to oil men, engineers and chemists, The Waverly Handbook is an outstanding aid to Engineering and Petroleum students. It has been adopted as a textbook by many of the country's leading engineering schools, and is subscribed to and approved by many of the high-ranking laboratories of the world.

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GULF PUBLISHING CO.

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Men in the Industry NEWS

J. L. Martin, left, retiring vice president and director of pipe lines for General Petroleum Corporation, was presented with an unusual memento of his 36 years of service by members of the company's Right-of-Way department. The gift consisted of two pieces of General Petroleum's oldest and most important lines: Main Line No. 1 which carried 107 million barrels of crude between 1913 and 1935, and Main Line No. 10, which carried 166 million barrels between 1935 and January 1, 1950. **Dan Collins,** right, Right-of-Way department manager, made the presentation.

•

G. Frick Poe, division superintendent of production in the Houston division, has been appointed general superintendent of The Ohio Oil Company's Production department and will headquarter in the company's general office at Findlay, Ohio. He succeeds **Fred E. Smith,** who has been named assistant manager of the Production department.

Other reassignments in the Production department include the appointment of **O. V. Henry,** formerly of Casper, Wyo., as Houston division superintendent. He is succeeded at Casper by **M. J. (Mike) Boyce,** formerly district superintendent of the Montana and Northern Wyoming district.

R. W. McCanne, Casper division geologist, has been named assistant to the manager of production at Findlay. **R. E. Knipe,** Terre Haute, Ind., division geologist, has been appointed Casper division geologist. **C. W. Donnelly,** geologist at Terre Haute, has been made division geologist there.

•

William R. Boyd, Jr., former president of the API, has opened his consulting law office at Teague, Texas. He will act as consultant-advisor to oil and gas company directorates, management and legal departments on matters related to public relations, inter-industry relationships and legislation. He will also initiate negotiations for the sale or purchase of oil or gas producing properties and for the merger or consolidation of oil or gas companies.

•

T. L. Francis has retired as northern division head payroll and social security clerk of Interestate Oil Pipe Line Company after 27 years service with the company.

B. C. Adams, Jr., formerly director and member of the executive operating staff of Cities Service Gas Company, Oklahoma City, has been made production and purchase superintendent of the Trunkline Gas Supply Company, a new affiliate of Panhandle Eastern Pipe Line Company.

•

E. K. Hartzell, assistant to the president of Cities Service Gas Company, has been made a member of the company board of directors. Hartzell, with Cities Service in Oklahoma since 1945, will have offices at Wichita.

•

Norval Franklin Myers has been elected a member of the board of directors of Anglo-American Oil Company, Ltd.

•

R. C. Stoner, vice president and director of Standard Oil Company of California, has retired after more than 36 years with the company. Stoner's first work in the oil industry was with Pacific Coast Oil Company's Kern River division during a school vacation in 1906. Stoner received a B. S. degree from the University of California in 1912, and in 1913 joined Standard of California in the Geological division of the Producing department.

R. C. Stoner

After successive advancements, Stoner was named general manager of the Producing department in 1931, and was elected a director of the company in 1938 and a vice president in 1941. He played an important part in the acquisition, organization and development of Arabian and Netherlands East Indies concessions.

Imagine TWO Hydraulic Gates—13⅝" bore

*in only 30" total cellar height!**

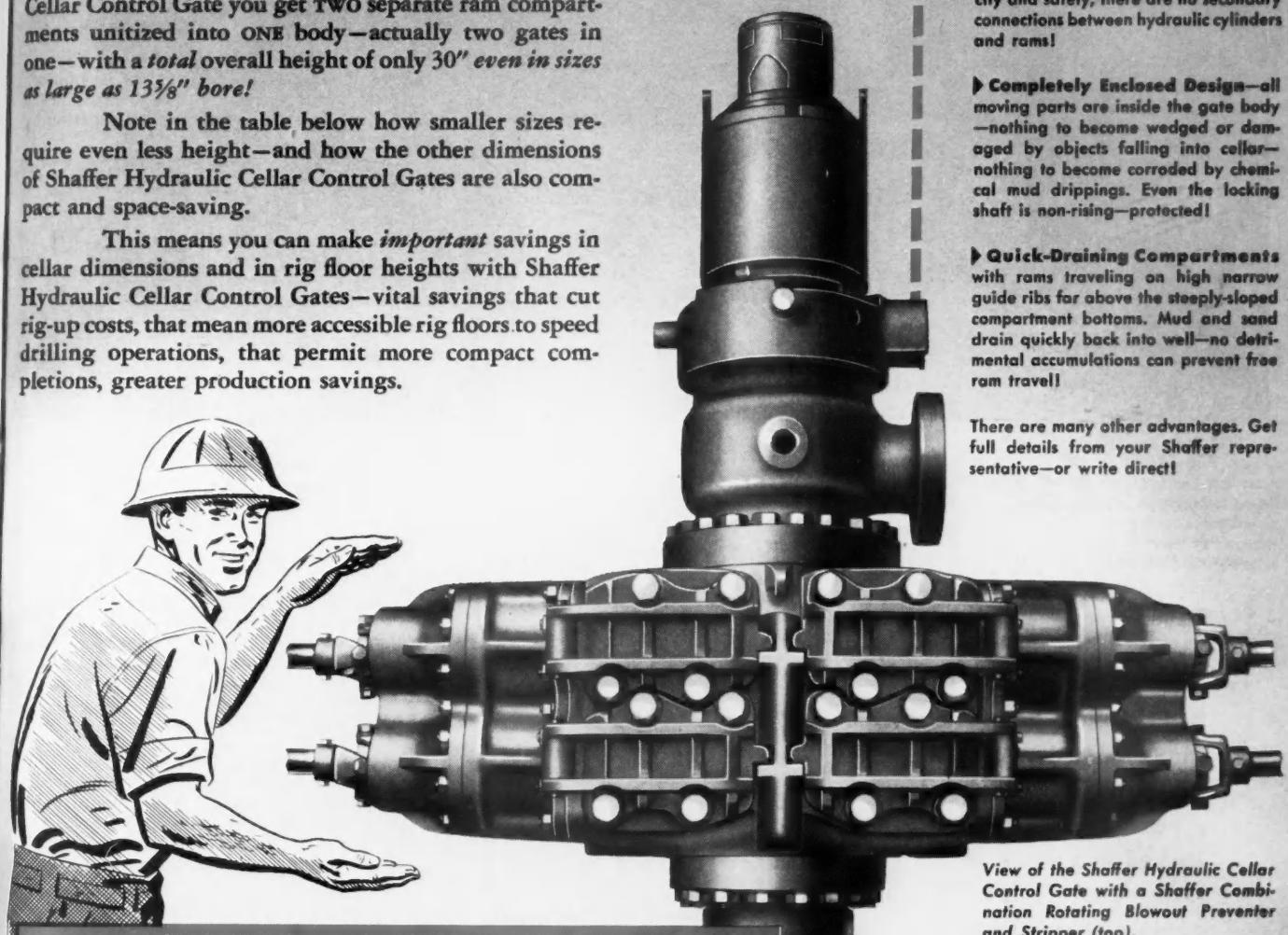
that's what you get in the NEW

SHAFFER Hydraulic CELLAR CONTROL GATE!

That's right—in the new Shaffer Hydraulic Cellar Control Gate you get TWO separate ram compartments unitized into ONE body—actually two gates in one—with a *total* overall height of only 30" *even in sizes as large as 13⅜" bore!*

Note in the table below how smaller sizes require even less height—and how the other dimensions of Shaffer Hydraulic Cellar Control Gates are also compact and space-saving.

This means you can make *important* savings in cellar dimensions and in rig floor heights with Shaffer Hydraulic Cellar Control Gates—vital savings that cut rig-up costs, that mean more accessible rig floors to speed drilling operations, that permit more compact completions, greater production savings.



View of the Shaffer Hydraulic Cellar Control Gate with a Shaffer Combination Rotating Blowout Preventer and Stripper (top).

SHAFFER HYDRAULIC GATE DIMENSIONS

Gate Size	7"		9"		10¾"		13⅜"	
Working Pressure (PSI)	3,000	5,000	3,000	5,000	3,000	5,000	3,000	5,000
Bore	7 1/16"		9"		11"		13⅜"	
A—Height . . . inches	25	26½	25¼	27½	27½	30½	30	36¼
B—Width . . . . inches	28⅝	31½	31⅝	35¼	34¼	37⅝	40	40½
C—Length . . . inches	70¾	70¾	71	72	79	81¼	88½	88½

**Smaller sizes even less height!*

And space-saving compactness—important as it is—is only one of *many* far-reaching advancements incorporated into the new Shaffer Hydraulic Cellar Control Gates. Some of the others are outlined at right, but space does not permit telling the *complete* story on this great new cellar control gate. So before you buy *any* control gate equipment, be sure to get ALL the facts about the new Shaffer Hydraulic Cellar Control Gate. It's the outstanding buy in the field!

These and Other Unique Features Are Yours In The New SHAFFER HYDRAULIC CELLAR CONTROL GATE!

▸ **Simple Ram Changes**—the simplest in any gate. Merely unbolt and swing open a side door, slide out the ram assembly, slide in the new assembly, close and bolt the door. It's that simple—*and complete ram changes can be made whether pipe is in or out of the well!*

▸ **Direct Hydraulic Drive** with the hydraulic operating cylinders *directly behind* the rams. For maximum simplicity and safety, there are no secondary connections between hydraulic cylinders and rams!

▸ **Completely Enclosed Design**—all moving parts are inside the gate body—nothing to become wedged or damaged by objects falling into cellar—nothing to become corroded by chemical mud drippings. Even the locking shaft is non-rising—protected!

▸ **Quick-Draining Compartments** with rams traveling on high narrow guide ribs far above the steeply-sloped compartment bottoms. Mud and sand drain quickly back into well—no detrimental accumulations can prevent free ram travel!

There are many other advantages. Get full details from your Shaffer representative—or write direct!

Send for your free copy of the complete Shaffer Catalog.

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

SHAFFER TOOL WORKS, Brea, California • California Service Shops: Santa Fe Springs and Taft
HOUSTON, TEXAS, 6006 Navigation Blvd. • ODESSA, TEXAS, 1925 West Second Street
OKLAHOMA CITY, OKLAHOMA, Acme Oil Tool Company, 1001 S. E. 29th Street
EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U.S.A.

26 YEARS OF OIL TOOL LEADERSHIP

James G. Craig, Continental Oil Company's superintendent of off-shore drilling operations, and **John H. Davis,** district geologist for the company's Gulf Coast Marine district, have been assigned to represent Continental in the company's joint operations with Magnolia Petroleum Company off the coast of Louisiana.

Davis, until recently geologist at Lafayette, was promoted to district geologist of the newly-formed Gulf Coast Marine district, with headquarters at Morgan City, La.

Craig was appointed superintendent of Continental's off-shore drilling operations in 1948. He will have his offices at Morgan City.

•

B. K. Ullmann, New York, has taken over the duties of **Andre Dubos,** who has resigned from Societe Nationale de Materiel pour la Recherche et l'Exploitation du Petrole (SNMAREP), purchasing agency for French operating oil companies.

R. L. Bosworth

Lloyd F. Thanhouser

Lloyd F. Thanhouser, Houston, has been elected a vice president of Continental Oil Company and will retain his present position as general counsel. **R. L. Bosworth,** Ponca City, Okla., was elected treasurer in addition to being financial vice president of the company, and **A. W. Tarkington,** former treasurer, Ponca City, was appointed assistant to the president.

A. W. Tarkington

Thanhouser, formerly a New York corporation attorney, was named general counsel of Continental last year. A graduate of Yale University, he received his law degree in 1926, and at the time he joined Continental was a partner in the law firm of Satterlee, Warfield & Stephens.

Bosworth has been with the company nearly 27 years, having joined the firm as a bookkeeper in 1923. After serving as an accountant, chief accountant, and New York office manager, he was elected treasurer in 1942, vice president in 1943, and financial vice president in 1948.

Tarkington joined Continental as treasurer in August, 1948. He was graduated with a B.S. degree in commerce from Southern Methodist University in 1932. After several years with the First National Bank of Dallas, he joined Bethlehem Supply Company, Tulsa, and resigned as assistant treasurer of that firm to join Continental.

•

Jerry T. Duggan, Kansas City, Mo., succeeds **Robert D. Garver,** retired, as chief counsel and head of the Legal department of the Gas Service Company, Tulsa.

•

Raymond B. Shepherd has been appointed traffic manager for Beacon Petroleum Company, and will headquarter in Tulsa.

•

Ralph A. McGoey resigned from Union Oil Company of California after 20 years of service to enter consulting business as petroleum engineer and geologist. McGoey, who was formerly Union's division superintendent, San Joaquin Valley, will headquarter at Bakersfield, Calif.

Bottom Water is a drain on profits

Eagle Lead Wool

shuts out Bottom Water!

To insure an uninterrupted flow of oil from your wells, banish bottom water with economical Eagle Lead Wool. This finely stranded metallic wool, tamped around the hole, effectively seals every crack, becomes a permanent, non-corrosive plug. Packed in convenient 50-pound sacks—easy to place in special cartridge-shaped Eagle Wire Containers sized to fit all casings.

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Seals off Bottom Water— keeps 'em flowing!

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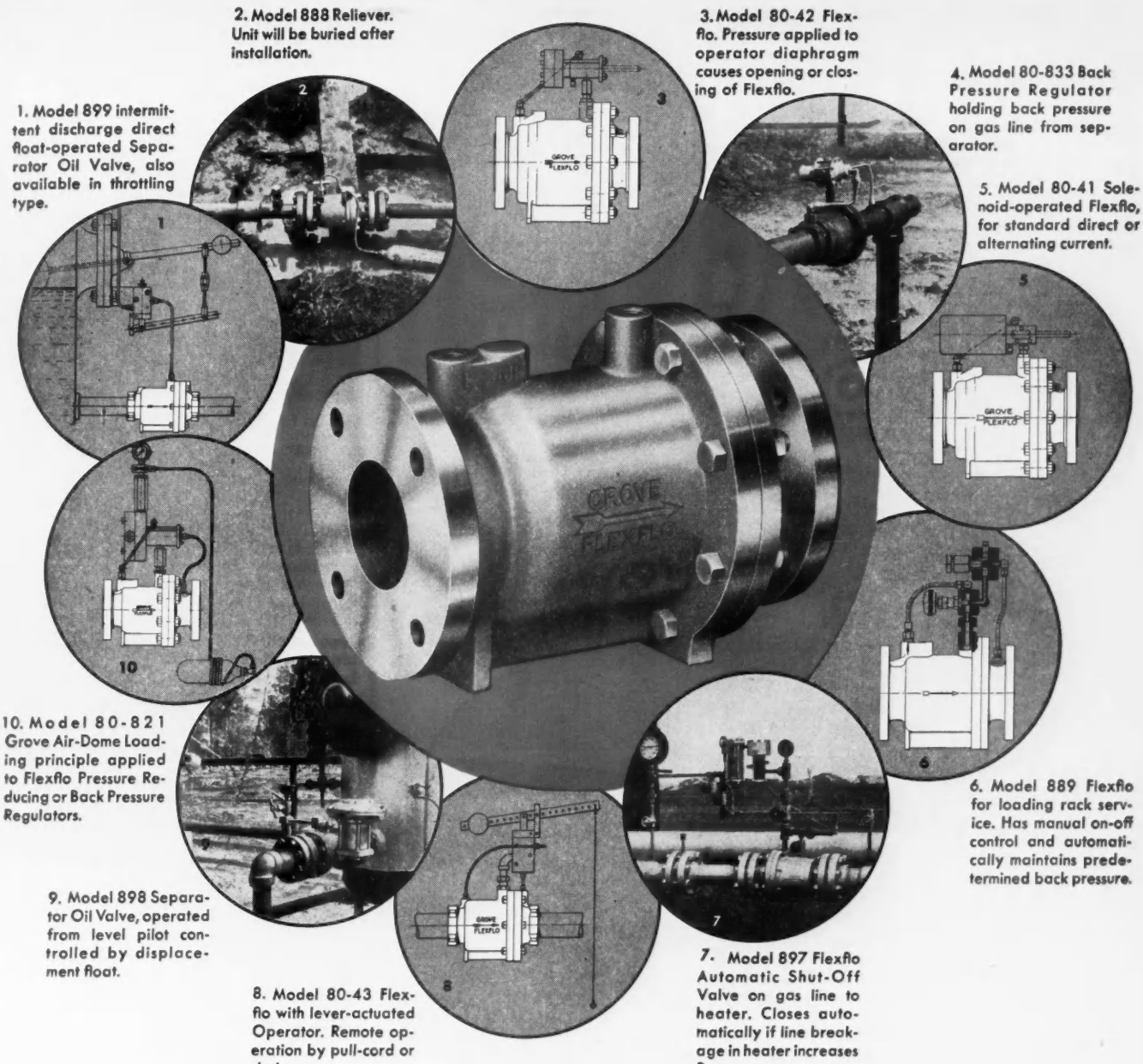

1. Model 899 intermittent discharge direct float-operated Separator Oil Valve, also available in throttling type.

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3. Model 80-42 Flexflo. Pressure applied to operator diaphragm causes opening or closing of Flexflo.

4. Model 80-833 Back Pressure Regulator holding back pressure on gas line from separator.

5. Model 80-41 Solenoid-operated Flexflo, for standard direct or alternating current.

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7. Model 897 Flexflo Automatic Shut-Off Valve on gas line to heater. Closes automatically if line breakage in heater increases flow.

8. Model 80-43 Flexflo with lever-actuated Operator. Remote operation by pull-cord or chain.

9. Model 898 Separator Oil Valve, operated from level pilot controlled by displacement float.

10. Model 80-821 Grove Air-Dome Loading principle applied to Flexflo Pressure Reducing or Back Pressure Regulators.

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The heart of each unit shown here is the never-failing Flexflo Valve. Whether your control problem is simple on-off; pressure reduction or relief; holding back-pressure; automatic shut-off; continuous or intermittent separator discharge, or any of a score of other services, the Flexflo is the valve for the job.

This flexibility is achieved through Grove's broad range of Operators. These Operators match and complement the Flexflo's ability to close bubble-tight, to resist corrosion and erosion, and to give the maximum of maintenance-free performance. Contact the nearest Grove office today for full details.

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WILLSON answers the problem of getting safety equipment worn by designing the utmost comfort into their entire line of eye and respiratory protective devices. The goggles illustrated have eyecups that are molded to fit the bony structure around the eyes. The chain bridge and elastic headband are adjustable for comfortable fit. And the Super-Tough* lenses meet or exceed Federal Specifications for optical clarity as well as impact resistance.

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In addition to product information, it contains information on safety glass, filter glass, respiratory hazards, etc., which will help you select proper safety equipment to meet specific hazards. Send for it!

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MEN IN THE INDUSTRY NEWS

Carl E. Totten, who has been with Shell Oil Company's Public Relations department in San Francisco since 1945, has been transferred to the Los Angeles office of the company, where he will head the Public Relations department. Totten succeeds **M. B. Shore,** who formerly held the Los Angeles post and who is now in the Los Angeles Marketing division.

Carl E. Totten

With the exception of a period of military service during the war, Totten has been with Shell since 1930.

•

Ruel Harris, a member of Shell Oil Company's Crude Oil department in New York for the past year, has been named manager of the company's Gas department in Tulsa, replacing **Richard Bard,** transferred to New York as assistant manager of the Crude Oil department in charge of volatiles. Harris joined Shell in 1938 after graduation from Oklahoma University. He was in the Tulsa territory from 1931 until 1941 when he entered the service and was separated as a Major in 1946. Bard was graduated from Ohio State University and joined Shell in 1944. He served in the company's New York and Houston offices before moving to Tulsa in 1948.

Ruel Harris

•

Cecil A. Hamman resigned as division engineer for The Pure Oil Company at Olney, Ill., and has joined **S. C. Yingling,** independent at Evansville, Ind. After being graduated from Purdue University and the University of Tulsa with mechanical and petroleum engineering degrees, Hamman was employed as a petroleum engineer in Oklahoma and Texas for nine years by The Ohio Oil Company. He then joined Pure in Texas and was later transferred to Olney.

Cecil A. Hamman

•

Ernest R. Love, formerly a vice president and director of Camay Drilling Company, has joined Stansbury, Inc., Bakersfield, Calif., as general superintendent in charge of drilling.

MEN IN THE INDUSTRY NEWS

K. H. Shaffer has been appointed assistant general manager of the Producing department of Standard Oil Company of California, and will direct oil field development work for the company.

K. H. Shaffer

First employed by Standard in 1929, Shaffer has worked in South America and California on engineering and organization problems relating to exploration and crude production. For the past two years he has been manager of producing in the Northern district, with headquarters at Taft, Calif.

Other personnel changes in the Producing department include the appointments of **C. W. Gibbs** as manager of the Northern district, and **F. A. Heitmeyer** as general superintendent of producing in that area.

•

Lester B. Johnson, Pleasantville, N. Y., has been appointed foreign exchange manager of Standard Oil Company (N. J.). Previously he was the company's senior foreign exchange analyst for the European and North African areas. He is succeeded as senior analyst by **Allan W. Hamilton,** Bronxville, N. Y.

•

C. Richard Coslow, assistant industrial relations advisor in the Foreign Trade department, Socony-Vacuum Oil Company, Inc., is being transferred, effective March 15, to assistant general manager of the company's operations in Austria. He will become general manager December 1 with retirement of **H. P. Rudinger.**

C. Richard Coslow

Coslow attended Cornell University, University of Pittsburgh, and the School of Advanced International Studies, Washington, D. C. After 11 years in the petroleum industry, Coslow started with Socony-Vacuum in February, 1946, as a staff assistant in the Training department, New York City division.

•

L. C. Monroe has been appointed traffic manager of Union Oil Company of California, to succeed **J. D. (Jack) Rearden,** who has retired after 43 years with the company.

Rearden joined Union Oil in 1906 as a clerk in the Traffic and Marine department. Monroe has been with the company since 1921, when he became a rate clerk at Los Angeles. He most recently was manager of distribution.

•

Arthur A. Seeligson, Sr., San Antonio oil man, has been added to the board of directors of Southwestern Fire and Casualty Company.

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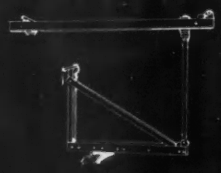

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DEATHS

Harry K. Floyd, 54, vice president and general manager of The Buckeye Pipe Line Company, died February 3 in Lima, Ohio. Floyd started in the pipe line industry in 1913 with Buckeye's gathering line division in southeastern Ohio. In 1948 he was elected vice president and general manager of Buckeye and its subsidiaries, Northern Pipe Line Company and New York Transit Company.

•

Carl Gibbons, 83, retired drilling company executive, died February 11, at Claremore, Okla. He had been vice president of Gibbons Drilling Company, Tulsa.

Louis Olsen, 65, Dallas, died February 4 in Miami, Fla. Olsen had been engaged in oil activities in the Mid-Continent area since 1917.

•

Kenneth W. Hagan, veteran Oklahoma oil scout, died February 2 at Okmulgee, Okla. He had been with Mid-Continent Petroleum Corporation since 1944 as an oil scout.

Samuel Lloyd Noble, 53, Ardmore, Okla., drilling contractor and president and chairman of the board of two Houston oil companies, died in Houston February 14. Noble was chairman of the board of Noble Drilling Corporation, and president and chairman of the board of the Sanedan Oil Corporation, both of Ardmore. The Houston firms he headed are J. S. Abercrombie Company and Old Ocean Oil Company.

Noble was a Republican party leader, and the only Republican from Carter County, Oklahoma, to serve in the State Legislature. He was a noted philanthropist and prominent in civic affairs.

•

Howard A. McDonald, 52, California independent producer, was killed in an automobile accident near Wasco, Calif., January 28. McDonald had been with Shell Oil Company in South America from 1925 to 1932. He served in the Army Corps of Engineers during World War II and was discharged as a major in 1945.

•

George Nelson Moore, 71, retired pioneer oil man, died February 11 at Decatur, Ill. He headed the Western Petroleum Refiners Association from 1921 to 1924.

•

John Wesley Painter, oil transportation expert and southwest regional director of the Office of Defense Transportation during World War II, died February 10 in Houston. He was owner of the Painter Transportation Service, which operates a fleet of railway oil tank cars. He had previously worked for The Texas Company and the Lillie W. Simms Oil Interests.

•

Lynn Wallace, 69, died February 4 near Oil City, Penn. He had engaged in leasing and producing in Oklahoma, Illinois, Arkansas, Mississippi and Pennsylvania.

•

Harry C. Taylor, 67, Tulsa, retired chief clerk of Sinclair Refining Company's Pipe Line department, died February 14.

•

Clay Briggs, 64, Cities Service Oil Company official, died February 18 in Bartlesville, Okla. He had been chief engineer of Cities Service since 1920, as well as vice president and general manager of Cities Service Transportation Chemical Company, Ponca City, Okla.; director of Empire Pipeline Company, the Texas Empire Pipeline Company, and the Texas-New Mexico Empire Pipeline Company.

•

Bert Miller, 67, pioneer oil well drilling contractor, died February 18 in Fairfield, Ill. He had been active in fields in Oklahoma, Illinois and Kentucky.

•

Henry Dundas, 72, a former director and vice president of Standard-Vacuum Oil Company, died February 12 at Miami Beach, Fla. Prior to his retirement in 1942 he had been associated with the international petroleum industry for 40 years.

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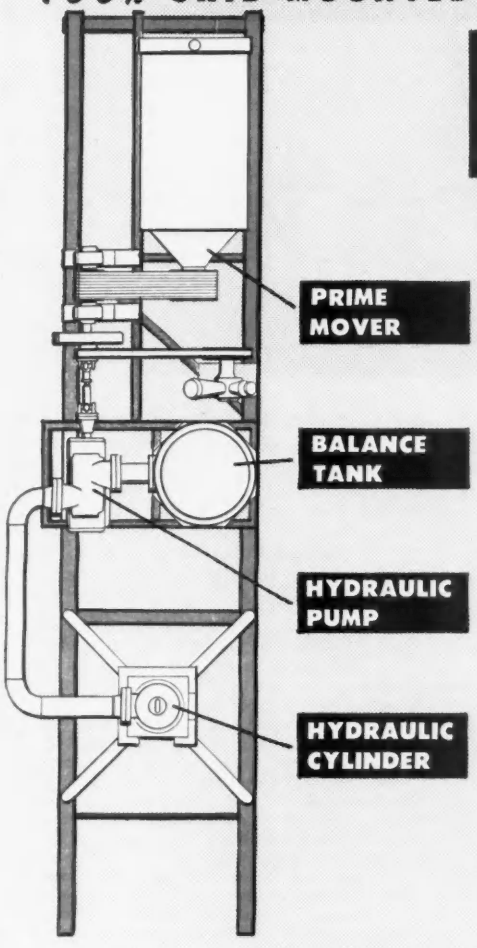
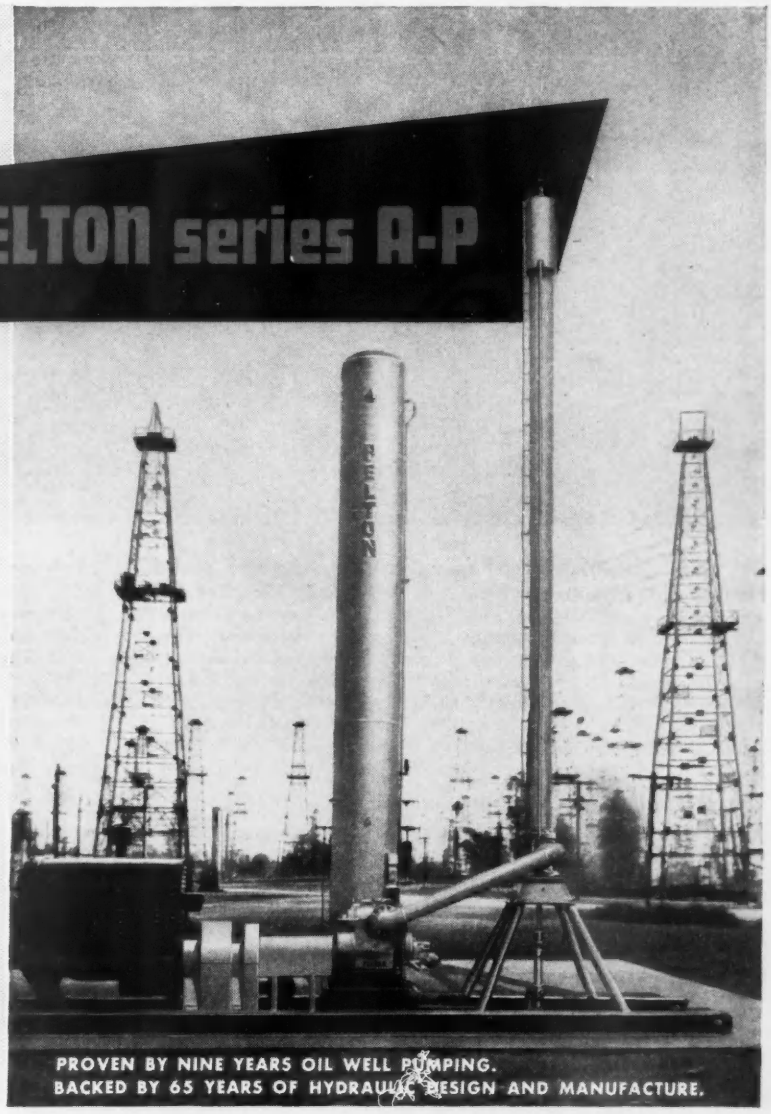


PELTON series A-P



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The PELTON A-P, which is completely skid mounted, complements the Standard Series A, in which the pump group and the prime mover are located any desired distance from the well, and the hydraulic cylinder is mounted at any desired height above the well. However, both the Series A and A-P incorporate new simplified operating controls, utilizing but two operating valves.

In the A-P design, the *complete jack*, including the prime mover, balance tank, hydraulic pump and the hydraulic cylinder, is mounted on a single portable skid. *Only one connection*, the gas line to the prime mover, is broken to move the jack on or off the well. The A-P design also makes it possible to work on the well *without breaking the hydraulic circuit* of the jack.

Pelton Jacks are available in 7 models with polished rod load ratings from 20,000 to 40,000 pounds. Stroke lengths 20, 25 and 30 feet.

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Associations

Mid-Continent District API Convention plans were discussed by the general committee at a meeting in Oklahoma City. Committee members shown are, front row, J. A. Kornfeld, Sohio Petroleum Company, publicity; George Rosen, Chambless Well Service, arrangements; Claude V. Barrow, The *Daily Oklahoman*, publicity; B. B. Burke, Lahoma Oil Corporation, publicity; Earle C. Flesher, Johnson & Flesher; Frank H. Willibrand, Sohio; George R. McDannold, Vinson Supply Company, hotels; Thomas E. Ashinhurst, Oklahoma City Chamber of Commerce; T. L. Regan, Stanolind Oil & Gas Company. Back row, William H. Strang, Dallas, API; W. W. Heavner, Continental Supply Company, Mid-Continent district secretary-treasurer; Ward M. Edinger, Production Engineering Laboratories, registrations; Glenn M. Stearns, British-American Oil Producing Company, programs; Joseph H. Field, Sohio, Mid-Continent District chairman; Dean A. McGee, Kerr-McGee Oil Industries, Inc., general chairman; Walter L. McCloy, Jr., Sohio; Carl A. Young, Dallas, API; Jack Harrigan, Standard Well Service Company, entertainment. Not shown are Seldon D. Butcher, geologist; and Tom C. Ockershauser, Globe Oil & Refining Company, hotel committee.

API Oklahoma City Meeting Planned

The spring meeting of the Mid-Continent District of the API, to be held March 29-31 at the Skirvin Tower Hotel in Oklahoma City, will be attended by about 700 production men.

Technical papers to be presented at the March 30 sessions include "Drilling by the Turbine Method," "Oil Emulsion Muds," "Relative Economies of Diamond Coring and Conventional Drilling," and "A Study of the Buckling of Rotary Drilling Strings." Scheduled for March 31 are "A Preliminary Report on Oil Recovery by High Pressure Gas Injection," "A Review of Gun-Perforating Methods," "Use of Plastic Pipe in Salt Water Disposal Operations," "Nine Years of Unit Operation at Shuler," and "Vocational Training in Oil Well Drilling and Production Operations."

A reception and buffet is planned for the night of March 29, with Oklahoma City oil men as hosts. The district banquet will take place March 30. March 29 has been reserved for meetings of District Drilling and Production Practices Committee, at which committee cooperation within the new national committee reorganization plan will be discussed. Dr. Herman H. Kaveler, Phillips Petroleum Company, Bartlesville, chairman, will explain the new program.

NACE Meet Lists Petroleum Papers

Technical papers treating of oil and gas industry corrosion problems, to be presented at the 1950 Conference and Exhibition of the National Association of Corrosion Engineers April 4-7, at St. Louis, include "Corrosion in Condensate and High Pressure Sweet Oil Wells," by R. C. Buchan, Humble Oil & Refining Company, Houston; and "Selection of Organic Protective Coatings for Marine Use in Petroleum Production," by Jack P. Barrett, Stanolind Oil and Gas Company, Tulsa.

To be read at the Pipe Line Symposium are "Surface Potential Method on Corrosion Survey of Pipe Lines," by O. W. Wade, Great Lakes Pipe Line Company, Independence, Mo.; "Internal and External Corrosion Experience in Shell's Products Pipe Lines," by S. S. Smith, E. H. Rush and W. J. Curry, Shell Oil Company, New York; and "Training Program for Corrosion Technicians," by James R. Cowles, Oklahoma Natural Gas Company, Tulsa.

Petroleum Economist Joins API

William B. Harper, petroleum economist, has joined the New York staff of the API as director of research. Harper has had six years' experience with the National Industrial Conference Board as petroleum economist and business analyst. During those years he founded the Petroleum Almanac. He was previously industrial analyst for the Standard and Poors Corporation.

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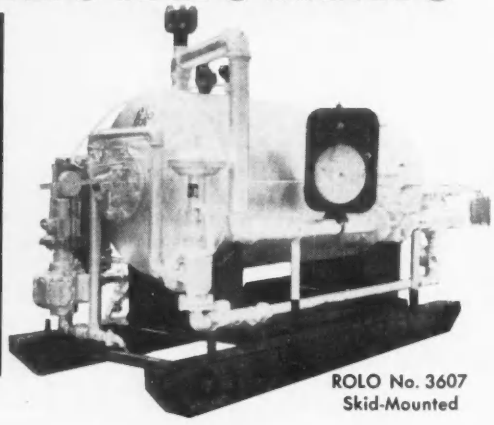
Permanent and Portable Oil and Gas Separators



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To help employers prevent on-the-job accidents and reduce accident costs, the Texas Employers' Insurance Association maintains the largest and most complete insurance safety engineering organization in the State of Texas. This department is manned by graduate engineers who work with employers and their employees in planning and conducting safety programs that not only reduce the number and severity of on-the-job accidents, but save money for the employers themselves. This saving results in reduced rates and increased dividends to employers. Do you have an effective safety program? Results prove that safety pays.

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HOMER E. MITCHELL, *Chairman of the Board* A. F. ALLEN, *President*

Southwest API to Meet March 8-10

Eleven papers will be presented at the spring meeting of the Southwestern district API Division of Production, March 8-10, Adolphus Hotel, Dallas.

At the first general session March 9, Guy L. Tate, vice president, Magnolia Petroleum Company, will present a paper on "What the API Public Relations Program Means to Oil Men," and F. H. Lahee, Sun Oil Company, Dallas, will speak on "Our Oil and Gas Reserves: Their Meaning and Limitations."

Technical subjects will be "Geological Interpretation of Dipmeter Results," by A. P. Claudet, Schlumberger Well Surveying Corporation, New Orleans; "Factors Affecting the Rate of Penetration in Hard Rock Formations," George E. Cannon and W. J. Bielstein, Humble Oil & Refining Company, Houston; "Use of Lime Base Muds," Jack L. Battle, Humble, and Preston E. Chaney, Sun Oil Company, Beaumont; "The Use of Meteorology in the Oil Industry," Joe E. Graham and Richard A. Geyer, Humble; "A Portable Resistivity Meter of Wide Range and High Sensitivity," W. H. Wilson, P. O. Reichertz and C. S. Kuhn, Magnolia; "Permeability Studies," Ralph F. Nielsen, J. J. McMahon and J. G. Heid, Pennsylvania State College, and S. T. Yuster, University of California; "Gas-Oil Ratio Repair and Control in West Texas and New Mexico," J. B. Lambert, Shell Oil Company, Odessa, Texas, and R. M. Hippard, Shell, Hobbs, N. M.; and "Dehydration of Natural Gas," R. C. Buchan, R. J. Sullivan, Milton Williams and H. H. Spain, Humble.

H. H. Kaveler, Phillips Petroleum Company, Bartlesville, Okla., will discuss "Streamlined Reorganization of the Tropical Committee Structure—Central Committee on Drilling and Production Practice," at the technical group session March 9. Drilling and Production Practice committees will meet March 8.

AAPG Elects Officers for 1950

Clarence L. Moody, division geologist, The Ohio Oil Company, Shreveport, was elected president of the American Association of Petroleum Geologists, succeeding C. W. Tomlinson of Ardmore, Okla.

Clarence L. Moody

Other officers elected for the 1950-51 term are John Emery Adams, Midland, Texas, vice president; Henry N. Toler, Jackson, Miss., re-elected secretary-treasurer; Alfred H. Bell, Urbana, Ill., re-elected editor.

Moody is a veteran of 32 years of continuous service with Ohio. He attended the University of Southern California and the University of California, and was an instructor of geology at Berkeley, Calif. After a year of graduate work in geology he moved to Casper, Wyo., as a consultant, and joined The Ohio in 1918. He has been active in the AAPG since 1932.

AIME Speaker Stresses Recovery

Colleges and universities should emphasize improved recovery methods more in their petroleum engineering curricula, Dr. H. H. Power, University of Texas Petroleum Engineering department chairman, stated in an address before the AIME Mineral Education division meeting in New York.

"The petroleum industry is giving increased attention to improved recovery methods," he stated. "Educational curricula should keep pace by giving adequate undergraduate background in such work for industrial careers and postgraduate training to meet research requirements."

Strang Joins Dallas API Staff

W. H. Strang, formerly executive secretary, Petroleum Branch of AIME, has joined the staff of the Division of Production, API, in Dallas, as assistant director in charge of engineering and district activities.

W. H. Strang

Strang was active in organizing and directing similar work with the AIME for four years. He was in the Armed Forces five years, and was released as a lieutenant colonel in the Ordnance department. For two years prior to his war service, he had been Gulf Coast editor of *The Oil Weekly*, predecessor of World Oil. He attended Colorado School of Mines and the University of Oklahoma, and was graduated from the latter in 1938 as a petroleum engineer.

Mid-Continent Group Sets Meeting

Mid-Continent Oil & Gas Association will hold its annual meeting November 2 and 3 at the Roosevelt Hotel, New Orleans. Tentative plans call for registration November 2, a luncheon at noon, a meeting in the afternoon and banquet that night. The morning of November 3 will be devoted to the annual meeting of the Executive Committee, with adjournment at noon.

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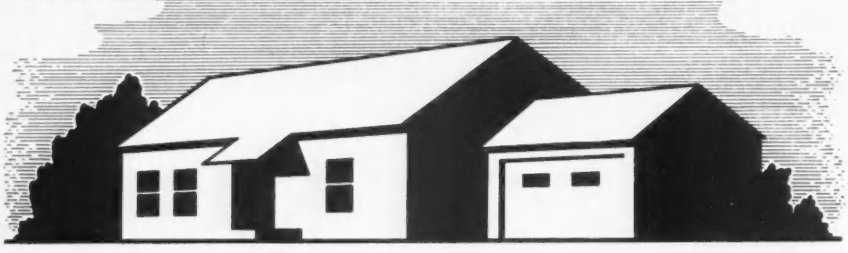

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OIL drilling 24 hours a day is just about the toughest job you can give an engine. Yet here are three "Caterpillar" Diesels (D13000) which jointly have made 400,000 feet of hole—have piled up over 90,000 engine hours (more than 30,000 apiece)—and have been in the shop for overhaul *just ONCE.*

There's not much further testimony needed to convince any drilling contractor of the quality, dependability and *durability* that are built into these tough-and-compact power units.

The Carco Drilling Company, of Dallas, is the owner of the pictured engine trio powering a Unit U-10 drawworks, a 7¼ x 14 "Oilwell" mud pump, and an Emsco 128-foot derrick. Carco is 100% "Caterpillar" with two other "Caterpillar" Oilfield Engines on another rig. Regardless of the location of your "Cat" powered rigs, they have a "Caterpillar" dealer and his 24-hour-a-day parts and service facilities as close as the phone. *Standardize and economize with "Cat" Oilfield Engines.*

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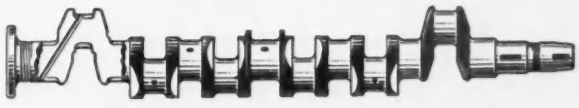

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7. Running with inside pipe cutting tools.
8. Running with fishing tools.
9. As all purpose, lightweight swivels.

Types 32-GA, 53-GA and 20-GW swivels are alike in general design, but vary somewhat in detail.

These swivels have been field proven by several years of services and have been accepted as leaders in their class. They are in service throughout most of the oil world.

There are no other swivels which are comparable on a basis of capacity in proportion to weight.

Their high capacity in relation to their lightness make them ideal for use in remote and inaccessible places.

The 53-GA is used for drilling medium depth oil wells; also used extensively on work-over rigs. It is an ideal swivel for slim hole drilling.

The 32-GA is used with large water well rigs and for drilling relatively shallow oil wells. It is also used with long strings of tubing for washing down and similar operations.

The 20-GW swivel is used for drilling shallow and medium depth wells. The 20-GW is the smaller of the three and is used on water wells, core drilling rigs and the heavier types of Geophysical Rigs. It is also suitable for handling tubing in the shallower oil fields.

All materials used in King Swivels are the best and most suitable for their purpose. Lubrication is provided and all connections are to API specifications or to the order of the customer.

Order Through Your Supply Store

EXPORT: R. S. STOKVIS & SONS, INC.

17 BATTERY PLACE, NEW YORK 4, N. Y.

See Composite Catalog for detailed description of other King Tools.

KING OIL TOOLS

210 TERMINAL STREET PHONE WO-8013

HOUSTON 20, TEXAS

Revision of the AAODC Accounting Manual was discussed at a special meeting of the sub-committee of the AAODC national accounting committee. The new edition, expected to be published in March, will include accounting procedures and theories approved since the first publication in 1945. From left to right are Kye Trout, AAODC, Dallas, committee secretary; W. K. Powell, accounting consultant; F. E. Godfrey, Big Chief Drilling Company, Oklahoma City; Robert H. Huey, Drilling and Exploration Company, Inc., Dallas; C. H. Todd, chairman of the national accounting committee, and E. H. Sloyer, both with Rine Drilling Company, Wichita, Kansas; W. L. McClusky, M. J. Delaney Company, Dallas, and D. C. Anderson, Rowan Drilling Company, Fort Worth. Leland Breckenridge, Geier-Jackson, Inc., Dallas, also attended the meeting.

Petroleum Branch Names Alford

Joe B. Alford of Dallas has been appointed executive secretary of the AIME Petroleum Branch. Since January, 1949, Alford has been editor of the *Journal of Petroleum Technology* and assistant secretary of the branch.

Joe B. Alford

In 1939 Alford was graduated from Texas Technological College with a degree in business administration, and joined Texas Power & Light Company in Dallas. He enlisted in the Army in 1940 and served until 1946, when he was released with the rank of major. Entering Leland Stanford University for the 1946-47 term, he acquired an M.A. in journalism, and then returned to Dallas, where he was engaged in public relations work before joining the AIME.

Pioneers Elect New Officers

Petroleum Production Pioneers elected S. F. Bowlby, vice president of Shell Oil Company, to serve as Pioneers president for 1950. Other new officers are Glen Merkley, The National Supply Company, vice president; L. L. Aubert, president of Bankline Oil Company, treasurer; Dick Sneddon, secretary; Joe Robinson, president of Santa Fe Drilling Company, sergeant-at-arms; and Ted Sutter, vice president of Baker Oil Tools, Inc., historian.

Honorary officers elected were R. E. Stearns, vice president of Universal Consolidated Oil Company, honorary president; Max App, vice president of General Petroleum Corporation, honorary vice president.

Pacific PESA Will Meet March 9

Petroleum Equipment Suppliers Association, Pacific division, will meet at the Ambassador Hotel Theatre and Embassy Room, Los Angeles, March 9.

Here's how the LD fills the bill for a LIGHT-DUTY FOUR WHEEL DRIVE

14,500 lbs. Gross Vehicle Weight

At last there is a *true* four-wheel-drive for the largest segment of the over-all truck field! The LD, born from FWD's unmatched experience in four-wheel-drive development, answers a great demand.

A *True* Four-Wheel-Drive Does *This!*

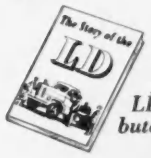
The only way to gain safety, economy and widened operation with a four-wheel-drive is to have proper distribution of load and power. FWD, alone, delivers those major advantages for this work-range.

The LD Has a *True* Truck Engine!

Only a *real* truck engine can give you peak efficiency for all the work demanding the LD. This efficiency creates on-the-job advantages, longer engine life and attractive savings in gas and oil.

Created for an Entirely New FWD work-range

One of the most important developments in 40 years of FWD leadership! Here is a completely new four-wheel-drive . . . designed to broaden the range of operation in the light-duty truck field. Now you can have a *true* four-wheel-drive to completely fill the needs which *conversions* and conventional trucks have sought to answer. This new model—the LD—fulfills countless requests for an FWD in that broad field.



GET ALL THE FACTS *on the LD! Ask for this folder, "The Story of the LD". See your FWD distributor or write FWD.*

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***Canadian Factory:* Kitchener, Ont.**
World-Wide Sales and Service

Built by the Makers of America's Foremost Heavy-Duty Trucks

EQUIPMENT AND SERVICE SUPPLIERS' NOTES

Lane-Wells Company Executives are pictured at the Managers Meeting in Los Angeles, where the group met to exchange ideas and develop new and better methods of serving Lane-Wells customers. Left to right, front row, are C. F. Ludwig, R. B. Downing, D. S. Jeppson, Norman L. Dorn, John J. Neale and J. W. McPhee. Back row, Ray Masters, E. A. Miller, L. H. Ingle, D. R. Dillehay, Val L. Forsyth, Morton T. Higgs, James D. Hughes, W. S. Keim, Jr., R. A. Hancock, Frank A. Taylor, P. M. Terrill, and W. A. Miller.

Schlumberger Announces Promotions

R. L. Forsythe and A. H. Curran, Jr., have received promotions into key positions in the Schlumberger Well Surveying Corporation.

Forsythe, formerly district manager for Schlumberger at Long Beach, Calif., has been transferred to the company's Canadian office in Calgary and has been promoted to assistant area manager. He is one of the two Americans representing Schlumberger in Canada. Forsythe has been with the company since 1937, and was working for the company in the Philippines when war broke out in 1941. He was a civilian guerilla fighter in the Philippines during the war, and rejoined Schlumberger at Long Beach after the Japanese surrender.

Curran, senior field engineer for the Long Beach district, has been promoted to district manager there. A graduate of the University of California, he joined Schlumberger in 1945 and transferred to Long Beach a year ago. As district manager he will work under F. G. (Fritz) Taves, Pacific Coast area manager.

G. J. Decker, district manager for Schlumberger at Hobbs, N. M., has moved to Edmonton, Alberta, Canada, on a special assignment. He will remain in Canada several months and then will return to another assignment in the U. S.

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All for a "package rate" of $16.00 for two, or $9.00 for one.
When making reservations, please specify "Weekend at the Skirvin."
DAN W. JAMES PRESIDENT
the Skirvin OKLAHOMA CITY

Rockwell Names Hurley at Houston

Rockwell Manufacturing Company has appointed H. L. Hurley to handle all major oil and engineering company accounts in the Houston district replacing J. W. Northcutt, who was appointed Atlanta district sales manager.

H. L. Hurley

Hurley has been with the company since 1943 as sales and service representative for valves and gas equipment in Southwest Texas. He is a veteran of World War II and studied engineering at the University of Texas. He also studied law and was admitted to the bar in Arkansas in 1935. Before joining Rockwell, he served as pipe superintendent for the Arthur G. McKee Company.

Bethlehem Sales Changes Announced

Bethlehem Supply Company announced the following personnel changes in its field sales organization: O. S. Grover, formerly in the Engineering Sales department, Tulsa, transferred to Dallas and promoted to chief clerk in the sales office; W. A. Langbein, formerly assistant district manager, Odessa, Texas, transferred to Dallas to assist in city sales contracts; C. W. Henry, former special representative, Pampa, Texas, appointed store manager and field representative there; D. G. Rhoads, recently employed as engineering representative, will be located at the district office, Shreveport; Curtis Stripling, former assistant store manager, New Iberia, La., transferred and promoted to field representative at Houma, La.; M. R. Griffith will operate out of the Houston district office in the Gulf Coast district; J. D. Wooten, formerly field representative, Sundown, Texas, transferred and promoted to store manager and field representative at Kermit, Texas.

Welding Division Manager Appointed

Harnischfeger Corporation, Milwaukee, has appointed Melvin O. Monsler as P&H Welding division manager. Monsler has been with P&H 12 years, including four years as assistant sales manager and one year as welding product service engineer.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Rolo Representative Is Appointed

Production Specialties Company, Midland, Texas, has been named engineering sales and service representative for Rolo Manufacturing Company of Houston, in West Texas and New Mexico, according to Lee Flood, owner of the Midland company.

Lee Flood

Production Specialties was formed early in 1949 to provide equipment and techniques for special production problems.

Flood was graduated as an engineer from Leland Stanford University in 1930. He was with the Natural Gas Pipeline Company of America, and was on the editorial staff of *The Petroleum Engineer*. Just before forming Production Specialties, Flood was chief engineer for the Goldsmith Pool Engineering Committee in Midland.

Geophysical Consultant Opens Office

Thomas R. Shugart, formerly vice president of Geotechnical Service Corporation, has opened offices in the Mercantile Securities Building, Dallas, as geophysical consultant, specializing in seismic interpretations and in seismic supervision.

Freeman Joins IDECO Sales

Rodney G. Freeman, Jr., has joined the Sales division of International Derrick & Equipment Company, it was announced by T. D. Collins, vice president, IDECO Supply Stores division. Freeman is a graduate of Mississippi State College where he studied mechanical engineering. He will work in the South Texas and Louisiana areas and will make his headquarters in the new Dresser building in Houston.

Rodney G. Freeman, Jr.

Tube Turns Moves Tulsa Office

The Tulsa office of Tube Turns, Inc., has been moved from 317 South Detroit Avenue to 420 Wright Building. Robert S. Tyler, Jr., is manager of the Tulsa office.

Tulsa Geologist Will Be Consultant

Dollie Radler Hall, since 1921 geologist for Amerada Petroleum Corporation, has resigned and has opened offices in the Philtower Building, Tulsa, to do consulting geological work.

Dollie Radler Hall

Mrs. Hall received her master's degree from the University of Oklahoma in 1921 and joined Amerada as assistant to the late Sidney Powers. Upon his death in 1932, she became acting chief geologist. She has been administrative geologist, division geologist in charge of Oklahoma and Kansas for the company, exploration geologist in the two states and more recently senior geologist in charge of drafting, reproduction work and technical file rooms for Amerada. She is a member of AAPG and the Tulsa Geologist Society.

PIPE VISE

plus... a handy work bench

RIDGID Tristand's tray keeps all your tools in easy reach

● No stooping, less fatigue and speedier work now that you don't have to bend over every time you change tools. New tray attaches in a jiffy, makes Tristand rigid so it can't fold up in use. Legs have rubber feet to prevent creeping. RIDGID's LonGrip tool-steel jaws won't slip, won't mar polished pipe and tubing. Yoke vise, 2½" capacity; chain vise, 4." Buy new work-saver RIDGID Tristands from your Supply House.

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STANDCO BRAKE LINING

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PAGE 270

EQUIPMENT and SERVICE SUPPLIERS' NOTES

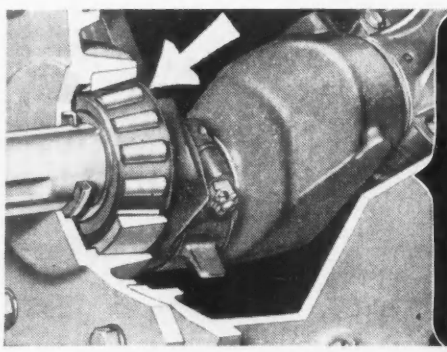
Rocky Mountain Distributor for Web Wilson Oil Tools is Dew-Card Oilfield Specialty Company, Casper, Wyo. Cecil Cardinal and Fred S. Dewel, owners, are shown with Miss Edith Pearson.

Sales Engineer Joins Steigerwald

The W. H. Steigerwald Company of Houston, distributors of the B. F. Goodrich Company's industrial rubber products in South Texas, announces the addition to their staff of Robert G. Wommack, sales engineer. A graduate of Rice Institute, Wommack served as chief engineer and minesweeping squadron repair officer in the Pacific and was attached to the fleet attending the Battleship Missouri in Tokyo Bay when the Japanese surrender was received. Returning to civil life, Wommack subsequently trained at the B. F. Goodrich plant at Akron and now devotes his full time to sales and engineering with W. H. Steigerwald Company. He is a member of the Houston Engineers Club, the API and the Society of American Military Engineers.

American Names Key Executive

Van H. Leichliter has been named assistant vice president, operations, by American Steel & Wire Company. Leichliter, who has been with the company since 1930, was formerly general superintendent of the company's South Works in Worcester, Mass.



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HEAVY-DUTY *Air-Cooled* **ENGINES**
Run on Timken Tapered Roller Bearings

Ever since the first Wisconsin Air-Cooled Engine was built over 20 years ago, the crankshaft of every one of these fine engines has been supported by Tapered Roller Bearings at BOTH ENDS. Here's why:

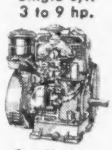
1. Tapered Roller Bearings take up all *End Thrusts* and *Radial Loads* (impossible with other types of bearings). You can mount your drive directly on the extended crankshaft of any Wisconsin Engine without the need for an extra thrust bearing or outboard bearing.

2. Tapered Roller Bearings *resist wear* to a greater extent than other types of bearings not only because of the file-hard surfaces of Timken Tapered Bearings but also because these bearings are inherently SELF-CLEANING. Oil enters at the smaller end of tapered roller bearings and centrifugal force carries it out through the large end, thus preventing accumulations of dirt and sludge that is often present in the oil. (Tapered bearings cannot develop shaft-cutting abrasive surfaces.

3. Tapered Roller Bearings permit flexing of the crankshaft to a much greater degree than the longer, rigid plain bearings which cannot stand up under flexing conditions, resulting in wearing "bell-mouthed" or failing completely. We have yet to hear of a single case of Wisconsin Engine bearing failure.

The use of Tapered Roller Bearings in ALL Wisconsin Engines from the smallest to the largest . . . 3 to 30 hp., single cylinder, 2-cylinder and 4-cylinder . . . is typical of the engineering diligence devoted to providing the user with "Most H.P. Hours of on-the-job service".

Single cyl. 3 to 9 hp.


2-cylinder 7 to13 hp.

V-type 4-cyl. 15-to 30 hp.

WISCONSIN MOTOR Corporation
MILWAUKEE 14, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

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Oil field distributors for Wisconsin Engines and all types of utility units.

Shooting Straight

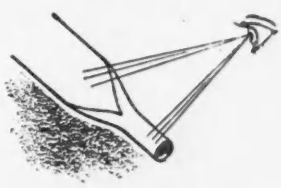
ACROSS THE LONE STAR STATE

another Republic Electric Weld Pipe Line.. 81 miles long

Straight lengths that line up evenly and go into the ditch freely helped speed construction of this 4½" O.D. pipe line in Waller County, Texas. As this line is designed to operate at 1000 pounds per square inch pressure, the uniform high yield strength of Republic Electric Weld Line Pipe is vital, too.

Straight lengths and high yield strength are but two of the ten outstanding qualities of this *modern* line pipe. All ten are listed below. They are the reasons why more than 55,000 miles of Republic Electric Weld Line Pipe have been placed in service during the past twenty-one years . . . the reasons why it continues to deliver ease of installation, trouble-free performance and dependable long life.

1. **Uniform Roundness**—Pipe ends match up perfectly . . . speed construction . . . cut costs.
2. **Uniform Diameter**—No "off-size" lengths to cause welding difficulties at joints.
3. **Uniform Wall Thickness**—Absolute dependability throughout every inch of length and circumference.
4. **Uniform High Yield Strength**—Permits building higher pressure lines—utilizing design values to fullest advantage.
5. **Uniformly Straight**—Lengths line up evenly . . . go into the ditch freely.
6. **Easy to Bend**—High ductility steel makes bending in the field easy.
7. **Easy to Weld**—Low carbon steel welds readily . . . makes sound joints.
8. **Freedom From Scale**—Insures against clogged valves, contamination of petroleum products.
9. **Long Lengths**—Reduces number of joints . . . makes jobs move with longer strides.
10. **Inspected Inside and Out**—Republic Electric Weld Line Pipe is made from flat-rolled steel both sides of which are closely inspected. Thus, you are assured that the surface which becomes the inside wall when formed into pipe is free from hidden defects.



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EQUIPMENT and SERVICE SUPPLIERS' NOTES

Mexican Crew

Plans made several years ago by Petroleos Mexicanos and Seismograph Service Corporation of Delaware (formerly Westby Geophysical Corporation in Mexico) for the formation of seismic crews comprised entirely of Mexican nationals have been realized in the organization of SSCD crew MM-1, now operating in the Poza Rica area.

All personnel of the crew either were graduated from or attended the Polytechnical Institute of Mexico. Party chief Santos Figueroa, shown second from left, served Pemex 13 years in the Tampico divisional offices as party chief and chief geophysicist. Chief computer is Daniel Gutierrez, second from right, who for seven years was a computer and party chief for Pemex, and who has been with SSCD crews two years. Armando Eguia, left, junior computer, spent four years with Pemex Geophysical department, and two years with SSCD crews. Observer Salvador Reynosa, right, was observer for five years for Pemex and two years with SSCD.

Additional Pemex employes are being trained in the U. S. and Mexico and will be assigned to SSCD crews upon completion of the training courses.

Bettis Forms Rubber Division

T. M. Smith, Jr.

A Rubber Products division of Bettis Corporation, Houston, has been formed to produce and distribute Trojan drill pipe protectors. T. M. (Tommie) Smith, Jr., formerly with Patterson-Ballagh, has been appointed manager of the division.

The Trojan protectors have been tested extensively in West Coast fields for about 12 years. They are available in natural rubber or special oil-resistant materials. A patented hydraulic applicator installs the protectors.

Tony Bilbo, former agent for Bettis Rubber Company of California, has also joined the Rubber Products division and will be stationed at New Iberia, La.

Wheeler, Ingraham Form Partnership

Dr. Robert R. Wheeler, geological consultant, and J. N. Ingraham, oil investments, have formed the partnership of Wheeler and Ingraham, with offices in the Continental Building, Dallas.

Price Tours Europe on Business

Harold C. Price, president of H. C. Price Company, pipe line constructors, Bartlesville, Okla., is on an extensive business trip through Europe. He will visit England, France and Italy during his two-month tour.

Carter Promotes Fred E. Lewin

Fred E. Lewin

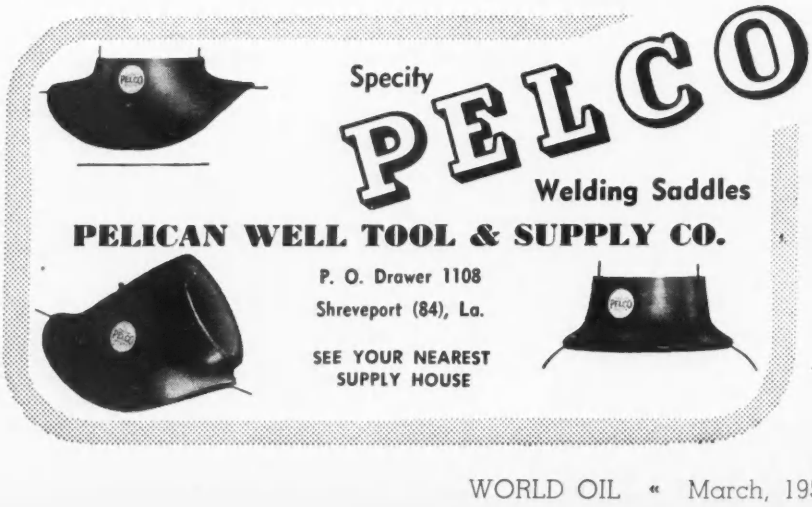
Ralph B. Carter Company has promoted Fred E. Lewin, vice president, to executive vice president and general manager. Lewin has been with the company nearly 15 years, and was previously sales manager and vice president in charge of all sales. In his new position, he will devote most of his time to sales and operational management of the company.

Disler Rejoins Pacific Pumps

After an absence of 18 months, Ed W. Disler has rejoined the Oil Well Plunger Pump division of Pacific Pumps, Inc., Huntington Park, Calif., and will be Northern division manager, with headquarters at Oildale, Calif.

Stoody Appoints Myrow Supply

The C. F. Myrow Supply Company, 4018 Aberdeen Way, Houston 5, has been appointed the distributor in South Texas and Gulf Coast areas for the Hard-Facing Alloy products of Stoody Company of Whittier, Calif. Headed by C. F. (Charlie) Myrow, for the past ten years district representative for Stoody, the new distributor will maintain complete stocks and will render field and engineering service on Stoody materials.



EQUIPMENT and SERVICE SUPPLIERS' NOTES

Rector Chooses Cementing Manager

D. F. Gunby

D. F. Gunby has been appointed manager of cementing equipment sales and service for Rector Well Equipment Company, and will headquarter in Fort Worth. Gunby majored in petroleum production engineering at the University of Oklahoma, and has engaged in production engineering, sales engineering and more recently in consulting work. He has been associated with Phillips Petroleum Company, Petroleum Administration for War and the Climax Engineering Company.

Ethriedge Is Field Representative

Hercules Tool Company, Tulsa, has appointed A. L. (Archie) Ethriedge as field representative for Oklahoma. He was formerly with Axelson Manufacturing Company as a field salesman with headquarters in Shreveport.

American Iron Adds Salesman

John B. Coulter, Jr., has joined the West Texas sales force of American Iron & Machine Works Company. He will maintain his residence at Midland, Texas, and work through the district sales office at Odessa, Texas.

Coulter is a graduate of George Washington University with a degree in mechanical engineering. Upon graduation from college he was connected with the Rowan Drilling Company for three years, and then with Hughes Tool Company for eight years. He was most recently connected with Drill Collar Service Company of Midland.

John B. Coulter, Jr.

Dallas Bank Has 30th Anniversary

Republic National Bank of Dallas observed its 30th anniversary in February. Now the 50th largest bank in the country, with a capital structure of $30 million, the Republic was organized originally as the Guaranty Bank and Trust Company, with a capital of $100,000.

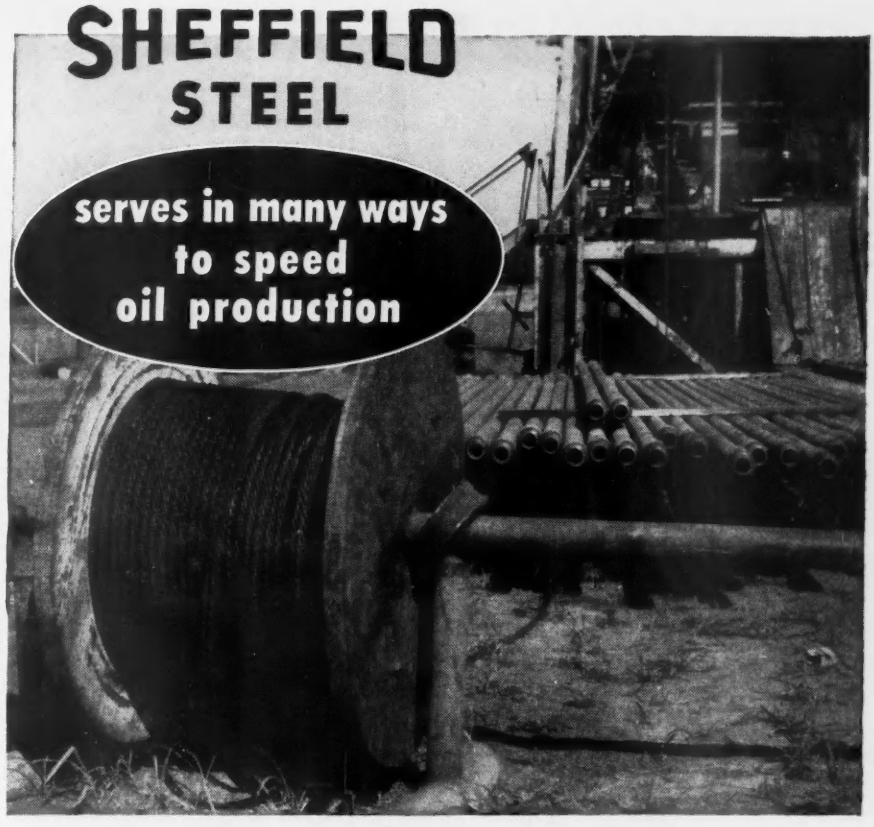
Florida Representative Appointed

Johnson Roney II

Black, Sivalls and Bryson, Inc., has appointed Johnson Roney II as Florida representative to handle safety heads and related products. Roney will headquarter at 608 Oak Avenue, Clearwater, Fla. He has had more than 30 years experience in engineering and sales. For 3½ years, he was sales manager for the La Bour Company, Inc., and since November, 1948, has been sales representative for manufacturing equipment firms.

Orbit Valves Names Casper Agent

LeRoy Mitchell, manufacturers' representative who heads The Great Western Company, Casper, Wyo., has been appointed to represent Orbit Valve Company products in the Rocky Mountain and Canadian oil fields.



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This oil industry steel is made in hundreds of different types and shapes to exact specifications in Sheffield mills at Houston and Kansas City and supplied to manufacturers of oil field equipment and steel products in semi-finished and finished form. This close link of co-operation between Sheffield steel making and the oil field supply industry assures the oil country that the steel it uses meets the most exacting requirements.

Carbon and Alloy Steel, Ingots, Blooms, Billets, Plates, Sheets, Merchant Bars, Steel Joists, Structural Shapes, Reinforcing Bars Welded Wire Mesh, Wire Products, Wire Rods, Fence, Spring Wire, Nails, Rivets, Grinding Media, Forgings, Track Spikes, Bolt and Nut Products

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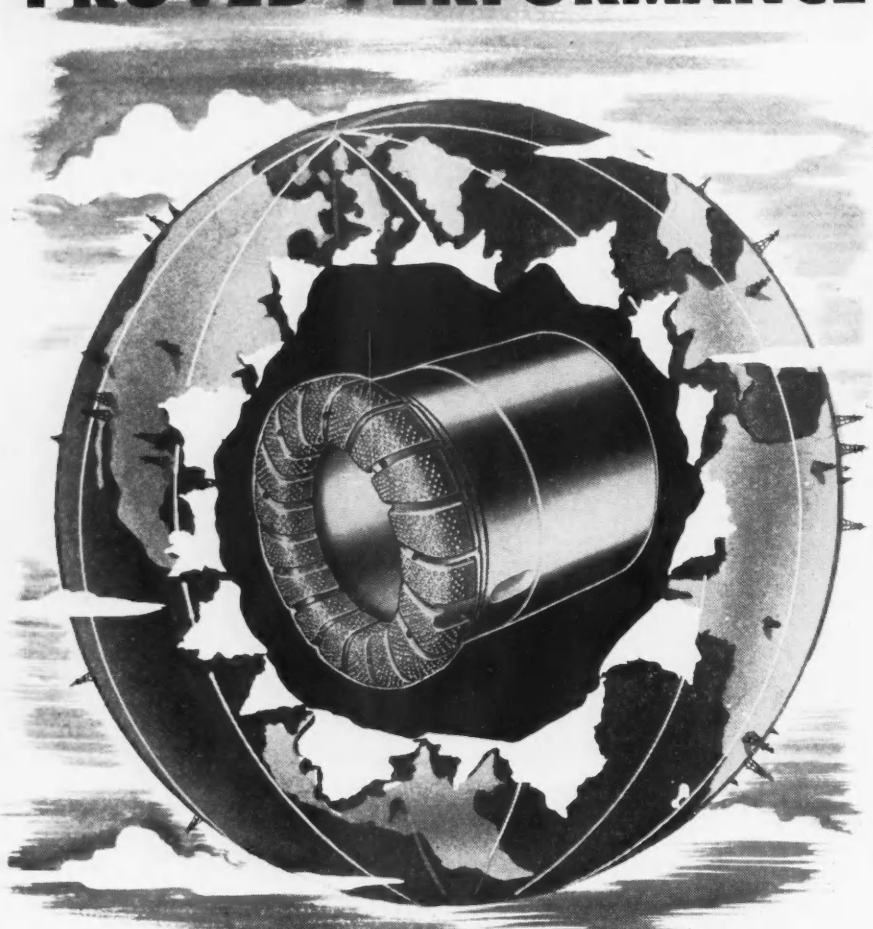

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CHRISTENSEN
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California Representative:
Mercury Oil Tool Co.
Los Angeles - Bakersfield

Export Representative:
R. J. Eiche & Associates, Inc.
Los Angeles - New York City

Canadian Representative:
James Emrick Company, Ltd.
Edmonton, Alberta

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Ben Reagor

Jack P. Schwartz

United Assigns Schwartz, Reagor

Jack P. Schwartz has been appointed head of the new Machinery Sales division of United Supply and Manufacturing Company, and Ben Reagor has been named Louisiana district manager.

Schwartz was formerly equipment engineer with Loffland Brothers Drilling Company. He has been associated with oil field heavy equipment since 1933 when he was with Waukesha Motor Company.

Reagor, formerly North Louisiana field representative for United, joined the company in 1948. His headquarters will be in Shreveport.

Fogle Is Southwest Sales Manager

H. P. Fogle has joined Standard Pipeprotection, Inc., St. Louis, as manager of sales for the Southwest area, with headquarters in Houston. He was formerly assistant division manager for Oil Well Supply Company at Houston.

Bessemer Is Union Malleable Agent

Bessemer Steel Corporation, New York, has been appointed to manage the export business of the Union Malleable Manufacturing Company, Ashland, O., maker of malleable iron pipe fittings, steel pipe nipples and cast copper solder fittings.

Empire Trust Promotes Rice

Empire Trust Company, New York, has promoted Charles Leslie Rice, Jr., from assistant vice president to vice president in charge of the bank's Oil and Gas division.

Mack Names Fleet Sales Executive

J. V. Doll has joined Mack-International Motor Truck Corporation as vice president, fleet sales, and as special assistant to H. W. Dodge, executive vice president.

J. V. Doll

For the past 20 years, Doll has been with The Texas Company as manager of its National Sales division. After serving overseas as major in World War I, he joined the White Motor Company as a salesman in Atlanta.

Later, as a member of the executive staff, he organized and headed White's National Sales department in Cleveland.

With Mack, Doll will headquarter in New York City.

Lovelady Named Sales Manager

Herschell A. Lovelady has been appointed sales manager for Standard Pipeprotection, Inc., with offices at 1411 South Winston, Tulsa. He was formerly sales manager for Jones & Laughlin Supply Company in Chicago, and more recently was in the purchasing department of The Texas Company.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Hyster Names Assistant Export Head

Hollis I. Conner has been appointed assistant manager of the Export division of the Hyster Company, with headquarters at Peoria, Ill. He will serve as contact man between export headquarters in Portland, Ore., and Hyster's two Eastern plants.

With the Hyster Company for the past four years during which time he spent six months in England, Sweden and other parts of Europe and two years in the Union of South Africa as export field representative, Conner will make a three months' tour of the Caribbean area before assuming his new position in Peoria.

Hollis I. Conner

Allegheny Ludlum Names Director

Joseph A. Martino, president of National Lead Company, has been elected to the board of directors of Allegheny Ludlum Steel Corporation. The two companies have formed the Titanium Metals Corporation of America, a jointly owned company for the development, sales and distribution of titanium metal.

Two Join Western Company Sales

Frank Turner and Dale M. Thomson have joined the sales staff of The Western Company, Midland, Texas. Turner was formerly manager of the West-

Dale M. Thomson

Frank Turner

ern Company's Odessa, Texas, station, and has been with the company since his discharge from the Army Air Force in 1945. Before the war, he was salesman for seven years with Rector Well Equipment Company in North Texas and Oklahoma.

Thomson started his career in the Land department of Phillips Petroleum Company in Tulsa and later was engaged in oil well acidizing and cementing for ten years with the Industrial Service division of Dowell Incorporated in the Mid-Continent area. He was in the drilling contracting business in that area before becoming one of Western's salesmen.

Byron Jackson Names Manager

Byron Jackson Company has promoted A. O. Wells to district manager in West Texas for Patterson-Ballagh, with headquarters in Odessa, Texas. Bob Shira, Gene Mitchell and Rhoal Lyles will be his assistants.

Engineer Goes to South America

J. Murray Walker, export sales engineer for Lane-Wells Company, is making an extensive trip through South America and Mexico. Walker joined Lane-Wells in 1937, and has served in both operations and sales departments of the company. He spent three years in Canada as manager of the Lane-Wells Canadian branch, and before taking his present position three years ago, was division sales engineer at Tulsa.

YOU DECIDE - WE PROVIDE

the BEST COMPOUND for tool joint protection

"There's nothing better than a Metallic Zinc Base Compound!"

Mister, what you need is WECO NO-GALL. Containing more than 50% pure metallic zinc, it exceeds manufacturers' specifications for this type compound. NO-GALL helps your tool joints deliver their expected performance efficiency . . . protects against galling, freezing, and thread friction. It will not squeeze out . . . will not harden. Requires no thinner.

"Metallic Lead Base Compound is best!"

When that's your decision, you want WECO STEEL-AID. This compound contains 67% pure metallic lead . . . which is even greater than the percentage specified by tool joint manufacturers. STEEL-AID will not squeeze out under extremely high torque or pressures, is non-hardening, has no fillers or other harmful ingredients and requires no thinner.

AND

Here's your best thread seal for casing, tubing, steam lines, oil and gas lines and others where leak-proof connections are essential. WECO HI-SPEED SEAL is non-hardening; requires no thinner. It seals with less torque . . . permits better make-up, faster breakout, protects threads.

ASK YOUR SUPPLY STORE FOR WECO COMPOUNDS

WELL EQUIPMENT MFG. CORP.

Subsidiary of Chiksan Company

HOUSTON 1, TEXAS

Exclusive Sales Representative Outside Mid-Continent Area

CHIKSAN COMPANY

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Export Sales: CHIKSAN EXPORT COMPANY, Brea Calif. New York 7

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RATES: Regular Classified (undisplayed) set in this size type: 10 cents per word. If Box Number is to be used count an additional six words. Replies forwarded without charge. Situation Wanted: 5 cents per word. Display advertisements, set in suitably larger type with ruled border: $9.00 per column inch per insertion. Situation Wanted: $4.50 per column inch. All classified ads payable in advance. 10% Discount if 3 or more insertions are ordered at one time. COPY DEADLINE: 5th of month preceding date of issue. Send copy and checks to: Trading Post Section, World Oil, P. O. Box 2608, Houston, Texas.

FOR SALE

■ Beech Bonanza for sale, standard equipment including extras. Zero hours on engine. 670 hours on airplane. Contact Bill Sidwell, Husky Refining Company, Box 380, Cody, Wyoming, Phone 500.

■ FOR SALE: 100 KW, 6 pole, 1200 RPM Alternator $1050.00. Subject to prior sale. Other closeout bargains, 2500 Watt, A.C. Lighting Plant $220.00, 10 Kilowatt, 1200 RPM powered with a Minneapolis-Moline Engine $825.00, 15 KW, 1800 RPM Generator only $380.00. Other miscellaneous Rotary Converters and Motor Generator sets. Kato Engineering Company, Mankato, Minnesota.

■ FOR SALE: Approximately 25 miles 4" OD plain end pipe in line. Public Service Corp. of Texas, 902 Burk Burnett Bldg., Fort Worth, Texas.

■ WELL DRILLING EQUIPMENT. New and used rotaries, spudders, core drills, shot hole and standard outfits. Tools, cable, pipe. Everything for well drilling. Pressey & Son, Pueblo, Colo.

Power barge, steel, 28'x94'x10', steel house, equipped with three 9x12 8-eye National Superior diesels and one LI-600 Cummins diesel, with generating capacity of 1050 KW. All necessary auxiliary equipment. Located LaPorte, Texas. For inspection contact W. Teer, Purchasing Department, Humble Oil & Refining Company, Houston, Texas.

FOR SALE: Two new welded propane tanks tested 200# cold water pressure, suitable for either propane or butane. Size 54" diameter x 37' 6" long, mounted on welded oil field skids, complete with fittings. Tanks never used, located Southern Louisiana. Offered at bargain price. Wire or phone Bethlehem Supply Company, Tulsa, Oklahoma.

Two 32 foot by 1¼" diameter BORESCOPE complete with transformers and box . . . Extra heads, tubes, guides and lens. First class condition. $500 each. Engineering & Development Company, PR-9968, 5513 Clinton Drive, Houston, Texas.

For sale: 1 Wichitex R-4-10" Mast Rotary Drilling rig, with 1 G. M. Diesel engine type G. M. 671. 1 - 7½x14 Gumbo Buster Mud Pump with Twin G. M. Diesel Drilling Engines Type G. M. 671. This rig has been to 4000 feet, is in excellent condition and will get the work done. This rig has a steel sub-structure, rat hole digger, and all necessary tools to start drilling. Complete with approximately 3700 feet 3½" drill pipe and 1200 feet 4½" drill pipe. P. O. Box 2364, Wichita Falls, Texas.

WANTED TO BUY

■ WANTED: 200 HP Engine at 1200 RPM, suitable for Generator drive for natural gas or adaptable. Kato Engineering Company, Mankato, Minnesota.

■ WANTED: Failing model 44, or 55 drill, or other make of similar capacity. Fred E. Butler, Box 1832, Casper, Wyo.

SITUATIONS WANTED

We are interested in capital and technique for the proper development of large and promising shallow oil field in Jarahueca, Cuba. A visit to the field would result most convincing. Write: Cia., Perforadora de Santa Clara, S. A., 158 Morro St., Habana, Cuba.

Draftsman, 35, married. 7 years experience in European oil fields. Geolog., soil, topograph, maps and survey. Technical knowledge of oil exploration and exploitation. Now working for a N. Y. map company, wants position in oil industry again. Address Box 70, c/o World Oil, Houston, Texas.

HELP WANTED

■ WE HAVE openings for experienced gravity crew men in foreign work. Excellent working conditions. All expenses and opportunity to advance and save money. Exploration Surveys, Inc., 5615 Daniels Avenue, Dallas 6, Texas.

Help Wanted

Graduate engineer experienced in the design of drilling rigs is offered a permanent position with old, reliable and progressive company located in the Southwest. Give background and experience. All answers confidential.

Address Box 71-W

WORLD OIL
3301 Buffalo Drive
Houston, Texas

WANTED

Engineer with experience in core analysis to supervise routine laboratory and research work and interpret routine results. Advanced degree preferred. Salary open. State experience, education and salary expected. Continental Oil Company, Personnel Division, Ponca City, Oklahoma.

NOTICES, SERVICES

■ 350 ACRES in Anderson County school land and Gatewood surveys, near producing wells at Blackfoot. Mrs. C. L. Jeffcoat, 711 Rainey Street, Palestine, Texas.

■ MOTORS — Generators — Transformers — Diesels — Compressors — "World's Largest Inventory." New and Rebuilt. Electric Equipment Company, Phone LD 65, Rochester, N. Y.— P. S. We will buy your surplus for cash.

■ TO SETTLE ESTATE, approximately 142 acres in Bexar and Atascosa counties. Not far from, and in line of heavy oil production. Box 184, Somerset, Texas.

LEASES, DRILLING, ACREAGE, ETC.

■ 80 ACRE LEASE in Artesia pool for sale with drilling obligation—Shallow, 640 acres in Loving County, Texas—shallow, Delaware, and deeper; between Wheat Pool and Kyle Pool. Large tract in Panhandle in trend 1½ to 3 miles from a pool of ten producing wells. John P. Mathis, P. O. Box 1106, Amarillo, Texas.

New Books,

Flow Meter Engineering

The seventh edition of "Principles and Practice of Flow Meter Engineering," by L. K. Spink, has much new material, including a new section by R. L. Parshall, inventor of the Parshall Flume. The new section gives design details, operating instructions, and tables for measuring flows through open channels by means of weirs and flumes.

The 416-page book contains information on calculating an orifice, flow nozzle, Venturi tube, pitot tube, or pipe elbow used for flow measurement. Common pressure tap locations are discussed, and data are given to correct for odd tap locations. Liquids, steam or other vapors, and gas, are handled in separate sections. Instructions, curves and tables are presented in logical sequence. Viscosity corrections are also provided.

Equations and curves for calculating throttling orifices to be used at critical pressure drops are a new addition to the book. Other new items include a section on measurements of fluid flow in metric units, a table of corrections for barometric pressures, a table of pressure multipliers up to 5000 pounds per square inch gauge, a description of practical methods of applying AGA Gas Measurement Committee Report No. 2, instructions for use of the square-root planimeter on gas meter charts, and examples of typical calculations in flow meter engineering.

The Foxboro Company, Foxboro, Mass., $7.

Northeast Texas Geology

A new map of the geology of a part of the Gulf Coastal Plain in Northeast Texas shows the variation of rock types, surface distribution, structure, thickness and some fossils of the Woodbine and adjacent Cretaceous formations.

The map, titled "Geology of the Woodbine Formation of Cooke, Grayson, and Fannin Counties, Texas," and accompanying data are published on two sheets. Approximately 1250 square miles are shown, on a scale of one inch to the mile.

Map Distribution Office, U. S. Geological Survey, Denver Federal Center, Denver, Colo., $1.

Kansas Statistics

"Summary of Secondary Recovery Production Statistics and Estimated Water-Flood Reserves, Kansas, 1948," was a joint project between agencies of the state of Kansas and the Interstate Oil Compact Commission. The report contains a history of production from eastern Kansas counties as well as statistics on production from all Kansas counties. Tables summarize the secondary recovery data on various Kansas counties. Production histories are presented graphically and nine maps of the producing areas of Eastern Kansas are included.

Interstate Oil Compact Commission, P. O. Box 3127, State Capitol, Oklahoma City 5.

Northern San Juan Basin

An area of 260 square miles on the northern rim of the San Juan Basin is shown on Preliminary Map 109, "Geology and Coal Resources of the Durango Area, La Plata and Montezuma Counties, Colorado," by A. D. Zapp.

Map Distribution Office, U. S. Geological Survey, Denver Federal Center, Denver, $1.

Multiple Drill Carriage

Report of Investigations 4625, "Development of a Successful Multiple Percussion Drill Carriage," by Homer J. Ballinger, Bureau of Mines mining engineer, describes a device which permits the simultaneous drilling of four 15-foot holes in tough rock. The carriage was developed by the Bureau's Oil-Shale Mining division as part of its program of devising methods and equipment for mining shale at the lowest possible cost.

Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13.

Maps and Movies

Scurry County Map

A new geological map of Scurry County, Texas, has been prepared by Keplinger & Wanenmacher, petroleum engineers, Tulsa. The map is drawn to a scale of one inch equals 4000 feet, and shows more than 1000 wells in the North Snyder, Diamond M, Kelley and Sharon Ridge pools, contoured on top of the Canyon Reef, principal producing formation in the trend.

Keplinger & Wanenmacher, 645 Kennedy Building, Tulsa. $90 on paper; $100 on linen.

Secondary Recovery Studies

Results of a Bureau of Mines study of the rates and pressures used for injecting water into several sandstone formations in the Mid-Continent fields to stimulate the recovery of oil are presented in a new technical report by Peter Grandone, Bureau petroleum engineer, and J. B. Holleymaa, formerly Bureau junior chemist.

The studies were conducted in 11 fields in southeastern Kansas, northeastern Oklahoma, and northern Texas. Their purpose was to learn more about the mechanics and efficiency of water flooding, and to provide useful information for operators using this secondary-recovery method.

Report of investigations 4600, titled "Injection Rates and Pressures for Water-Flooding Mid-Continent Oil Sands," discusses the theory of water injection, and describes the method used for measuring injection rates and pressures. It also includes detailed results of tests made in each of the fields studied. Diagrams and tables supplement the text.

Bureau of Mines, Publication Distribution Section, 4800 Forbes Street, Pittsburgh 13.

Wyoming Map

Preliminary Map 107, "Map of Wyoming Showing Test Wells for Oil and Gas, Anticlinal Axes, Oil and Gas Fields, Pipe Lines, Unit Areas and Land District Boundaries," was prepared by Eleanor K. Keefer, R. M. Larsen, J. D. Love and Maxine D. Allen. This map, a revision of Preliminary Map 19, is up to date as of May 1, 1949. The map is printed on two sheets.

Map Distribution Office, U. S. Geological Survey, Denver Federal Center, Denver. $1.

Oil Shale Patents

U. S. and foreign patents relating to the mining and retorting of oil shale and the recovery of its products have been compiled in a 650-page volume by Simon Klosky, of the U. S. Bureau of Mines. The book, Bulletin 468, contains 595 figures, and a short notice of each of the patents on oil shale available in the U. S. Patent Office as of January 1, 1945. It is in three parts: U. S. patents, other English language patents, and European language patents. Each part is followed by an index, listing the inventors and assignees alphabetically.

Superintendent of Documents, Government Printing Office, Washington 25, D. C., $1.50.

Compilation of Maps

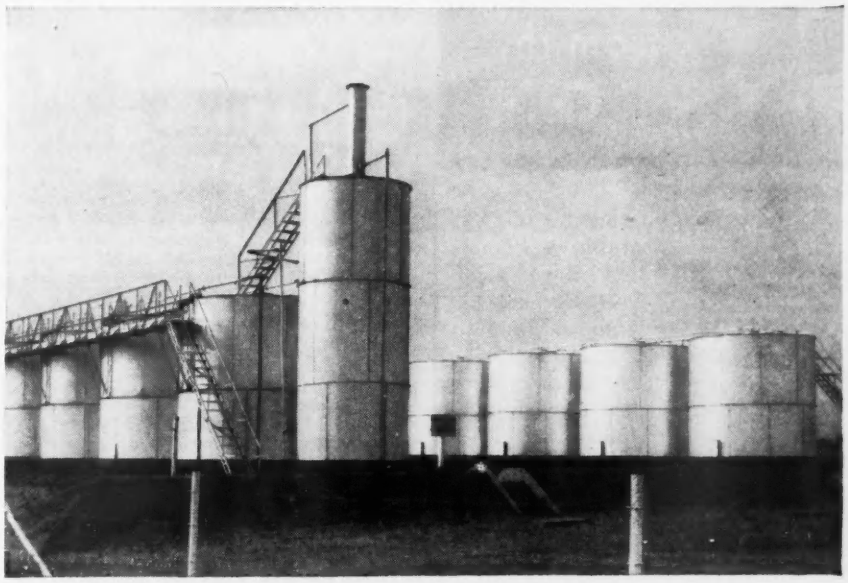
Preliminary maps, reports and charts issued by the U. S. Geological Survey's Geologic division in 1946-47 and by the Conservation division in 1938-47, are listed in a new bulletin. Information is included on chief commodity of each mapped area, state and county, title, author, date of field work, price and method of map reproduction, text title and author, press release title and date, and addresses at which the map or report is available.

Geologic division maps cover areas studied and mapped by Survey geologists in the U. S., Alaska and Mexico. Conservation division's maps and reports concern the production history, geology or topography of federally owned or controlled lands with regard to water power, gas, oil and minerals resources; these cover areas in 12 states and Alaska.

The circular, compiled by Ruth A. Atherton, Wenonah A. Eckstein and R. E. Spratt, is issued as U. S. Geological Survey Circular 56.

Director, U. S. Geological Survey, Washington 25, D. C.

When your Wells come in...



Specify **Butler Bolted Oil Tanks**

In single tank units—or batteries—Butler Bolted Oil Tanks furnish oiltight facilities for the storage and handling of crude or finished petroleum products. Sheets are precision-formed for fast easy erection of tanks. Extra strength and stamina give longer service life.

And here's an extra Butler advantage! All sheets in Butler Bolted Tanks are painted by Electrostatic Spray—newest scientific technique which assures uniform coating and a tight long-life bond between finish and sheet. Paint lasts longer...gives better protection...costs you less.

Galvanized steel tanks are also available. Here, Butler uses the hot-dip galvanizing process which produces a heavy coating of the galvanizing on every surface and gives complete protection from weather and corrosive elements.

Butler Bolted Tanks are built to A. P. I. specifications. Sizes and types to meet your needs. Call your nearest Butler oilfield organization today for complete information and prompt service.

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Call These Experts for Prompt Service

AMERICAN PIPE & SUPPLY CO.
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BOLTED TANKS • WALKWAYS

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Flashes from the BEACON

ASK US to pick a number. O. K. —141,121,000. That's how many inches of BEACON copy came off the press in 1949. For people who like to string things end to end, it figures some 22,293 miles of type on paper. But no single reader was exposed to more than around two and a quarter miles of it.

"He rang it!" . . .
a BEACON original by Dave Hunt

* * *

BS&B employees are the only readers who get the BEACON automatically. All other names on the list got there by written request of the reader himself or one of the BS&B sales or other executive staff.

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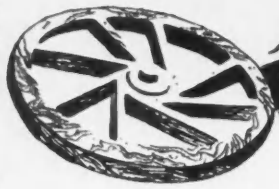
ASK US to pick a number. O. K. —12,000. That's how many BEACON readers there are right now. Who reads the BEACON? A pretty representative cross section of America. Want to be 12,001 on our list? It isn't hard . . . Just a request on your company letterhead will do it.

Write to:

BLACK, SIVALLS & BRYSON, INC.
Industrial and Public Relation Division
720 Delaware
Kansas City, Missouri



SQUEAKS from the BULLWHEEL

Economics—1950 Version

Six-year-old Willie was lecturing little George, aged three, on the value of various coins in his pocket.

"Now this," he said, "is a dime. It will buy two candy bars. And this," he continued "is a nickel. It will buy only one candy bar."

He fished around and brought out a third coin. "And this," he said with a faintly contemptuous air, "is a penny. All it is good for is Sunday school!"

Signal Significance

Auto Examiner: "Do you know what it means if a driver puts out a hand?"

Applicant: "Well, if it's a woman, it means she is going to turn right or left, shake the ashes off her cigarette, or reverse or stop, or she's pointing to a hat store, or admiring her ring, or . . ."

Examiner: "Yeah, and if it's a man?"

Applicant: "Why, he's usually waving at a woman."

Evidence

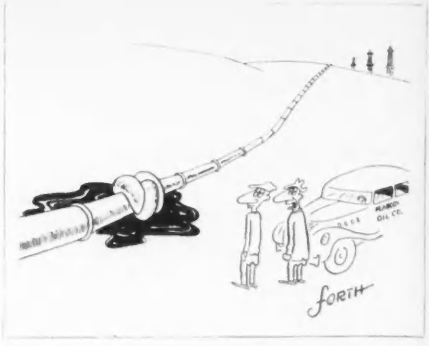
"Officer, what makes you think this gentleman is intoxicated?"

"Well, Judge, I didn't bother him when he staggered down the street, or when he fell flat on his face, but when he put a nickel in the mail box, looked up at the clock on the tower, and said, 'My God, I've lost 14 pounds,' I brought him in."

Just Human Nature

His health wasn't any too good, so the Eastern city-dweller went looking for a place to live in the Southwest. In one small town in Arizona, he approached an old timer sitting on the steps of the general store. "Say," he asked, "what's the death rate around here?"

"Same as it is back East, bub," answered the old fellow. "One to a person."



"Hereafter, Bently, don't treat a break in the line like a shoe lace."

The Contrary Sex

The beautiful blonde was trying to impress her friend. "There I was, poor little me, locked in a room with 11 men, and each one trying to break down my resistance. But I defied them all, both individually and collectively."

"Heavens, dear!" her friend exclaimed. "Were you kidnaped?"

"Don't be silly. I was doing jury duty last week."

Cheater

"So you deceived your husband," said the judge gravely.

"On the contrary, he deceived me. He said he was going out of town and he didn't."

Nothing to Say

Doctor: "And there's really no reason to worry about that habit of yours of talking to yourself."

Patient: "Perhaps not, but I'm such a damned bore."

GOTKOOL WATER CAN
Made in 1½, 2, 3, 5, 10, 15 and 20 gallon sizes. (Push-Button Faucet at slight additional cost.)

Gotkool
WATER CANS & COOLERS

GOTT Water Cans are the practical way to keep drinking water cool for long periods, protected from impurities and always handy to the job. Snug fitting large removable top, strongly built to withstand rough usage. GOTT Water Coolers have extra large covers and a handy non-leaking push button faucet. Your Supply Store has them, get one today! . . . . . .

GOTKOOL WATER COOLER
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H. P. GOTT MFG. CO.
WINFIELD, KANSAS

KEEP PURE DRINKING WATER ALWAYS HANDY

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McCullough

goes **ANYWHERE** to do your

FISHING JOBS

with the

FINEST FISHING TOOLS

•

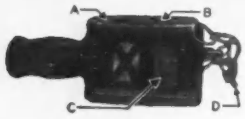
POSITIVE KNOWLEDGE
of just where pipe is stuck, and

•

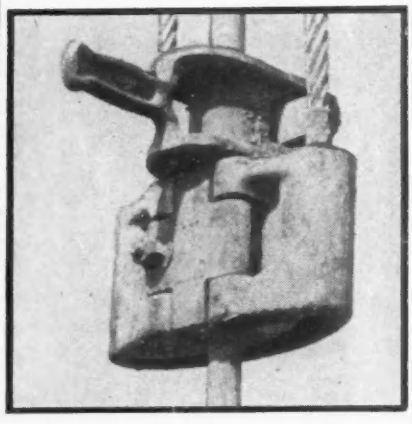
THOROUGHLY EXPERIENCED MEN

The MAGNA-TECTOR shows just where pipe is stuck
Self-Feeding EXTERNAL CASING CUTTER
Rotary Releasing SPEAR
BUMPER SUB
Rotary Releasing SOCKET
Long Knife Internal CASING CUTTER
Double-Acting ROTARY JAR Strikes Blows Both UP and DOWN

A POLISHED ROD CLAMP THAT IS EASIER TO USE *GRIPS LIKE A BULL DOG*



- Only 3 main parts: Body (A), Follower (B) and Wedge (C) connected together by a strong chain (D).
- Only a hammer is needed to put on or take off this clamp. Easy to do and saves time.
- Easy to handle with gloved hands. No nuts or washers to fumble or lose.
- Clamp is tough and strong because main parts are made of heat-treated alloy steel.
- Used to hang a well off, to space rods or as a pumping grip—whether wells are shallow or deep.



Ideal for use as a pumping grip, clamps like this one pay for themselves in time saved.

TWO MODELS

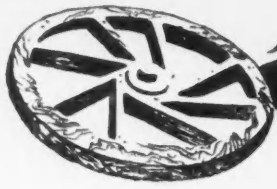
REGULAR: For wells up to 5000 feet. Two sizes—for 1⅛" or 1¼" polished rods.

MILELIFT: For wells over 5000 feet, or for heavier rods in shallower wells. Three sizes—for 1⅛" or 1¼" or 1½" polished rods.

Sold by Supply Stores

WALTER O'BANNON COMPANY

TULSA 1, OKLAHOMA



SQUEAKS from the BULLWHEEL

Moot

Two women, dining in a restaurant, were discussing a third, who had just made her entrance.

"Her husband was a judge, wasn't he?" one woman asked.

"Everyone thought so," replied the other, "until he married her."

Friends to the End

Hotel guest: "I want a refund on my hotel bill. There's a dead cockroach in my room."

Manager: "But a dead cockroach—that's no reason for a refund!"

Guest: "Oh no? You should see the funeral he's getting!"

Absenteeism

Eddie, the hardware clerk, had made a name for himself as the most inefficient and discourteous salesman ever. The atmosphere when he was absent one day was like the tranquil beauty of summer weather after a thunderstorm. One regular customer remarked on the difference.

"Eddie ain't just away," said the proprietor, "he don't work here any more."

"Do you have anyone in mind for the vacancy?" the customer asked.

"Nope," said the proprietor. "Eddie didn't leave no vacancy."

Identification

Policeman to pedestrian just struck by hit-and-run driver: "Did you get his license number?"

Victim: "No, but I would know his laugh anywhere."

Too Tricky

During the long evenings at sea sailors on a freighter were frequently entertained by one of their number, a sleight-of-hand performer of no mean ability. His act, in which cards, money and handkerchiefs were made to disappear, was enjoyed by all aboard—except one—a parrot which greeted each performance with a raucous "Ha, ha, ha! Phooey!"

The ninth night out, in the midst of the show, a terrific storm arose and the ship sank. The prestidigitator was blown into the ocean and managed to grasp some wreckage to support his weight.

The following morning, he was startled to see his critic, the parrot, sitting on an upright on his improvised raft. Not a word passed between the castaways for two days. Suddenly, however, the parrot looked down, cocked his head to one side, and with a gleam in his eye, demanded: "All right, what'd you do with the ship?"

New Directions

"Say, this car you sold me can't climb a hill! You swore up and down it was a good car."

"I didn't swear up and down. All I said was that on the level it was a good car."

Disadvantage

"My poor man," said the lady to the beggar, handing him a dollar bill. "It must be terrible to be lame like you are, but think how much worse it would be if you were blind."

"You're shore right there, lady," the bum agreed. "When I was blind somebody was always givin' me counterfeit money."

Ante Up!

There's the touching story of the young man who said to his girl: "I'll betcha you wouldn't marry me!"

The story goes that she not only called his bet but raised him five.

He Made the Grade

A university student, who had come under the spell of modern education, came to the examination question, "What causes a depression?" He wrote: "God knows! I don't! Merry Xmas!"

When the examination paper came back, he found the professor's notation. "God gets 100. You get zero. Happy New Year!"